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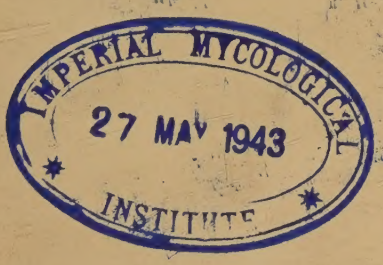

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QUEENSLAND

COTTON RESEARCH STATION, BILOELA

BY

W. G. WELLS.

Introductory Note.

Cotton was first grown commercially in Queensland in 1852 when 70 bales of lint cotton forwarded to England realized attractive prices. Following on the outbreak of the American Civil War, an appreciable number of people emigrated from Great Britain to the south-eastern portion of Queensland for the purpose of growing cotton. Good returns were obtained and during the period 1868 to 1873 a total of 20,044 bales, averaging 500 lb. of lint cotton, was forwarded to England. The resumption of cotton-growing in the United States of America following the cessation of hostilities soon caused a marked reduction in the prices obtained for Queensland cotton. Interest in the crop therefore quickly declined here, and within a few years the industry was practically extinct.

Spasmodic efforts were made to revive cotton-growing in Queensland from time to time, but no substantial progress was made until the end of the 1914–18 war when the high price of cotton and a reduced production of long stapled varieties in the United States of America again created interest in this crop in Australia. Attempts were made to grow it in several States, but the most promising results were obtained in Queensland. By means of Government guaranteed prices production was quickly stimulated until in 1923–24 an estimated 50,000 acres of cotton were planted, mainly in the south-eastern section of this State.

Fairly favourable weather conditions for cotton-growing were mostly experienced during this period of rapid expansion and many excellent yields were obtained under a variety of combinations of cultural methods and soil types. However, in the first season in which the planting rains were delayed until mid-November and very wet weather was experienced in February, many partial or total crop failures, caused mostly by corn ear worm, occurred in all of the cotton-growing districts. This not only stopped the expansion of the industry under " boom " conditions but gave clear-cut evidence that there were many problems to be solved before it could be soundly established.

A repetition of somewhat similar climatic conditions in subsequent seasons caused a rapid decline in cotton-growing in the older settled districts, but in the more recently settled parts better yields were obtained.

The resumption for closer settlement of cattle stations comprising some three million acres of open forest land and densely covered scrub

areas in the Upper Burnett and Callide Valley districts, resulted in the shifting of the centre of cotton production into mostly newly-settled areas. It was decided, therefore, to establish an investigational centre in the Callide Valley to ascertain not only the best methods of growing cotton for the newer districts, but to lay down long-time programmes to provide information which might indicate the problems likely to be encountered in the future. Accordingly, in July, 1924, the demonstration area at Biloela, which had been developed to indicate to the intending settlers the crops that could be grown in the district, was taken over for the establishment of the Cotton Research Station.

With the assistance of substantial funds kindly supplied by the Empire Cotton Growing Corporation, suitable facilities were developed to enable a comprehensive programme of investigations to be undertaken, which over the years has been modified in the light of experience.

The results obtained at the Research Station have amply demonstrated the wisdom of establishing such a centre. During the first few seasons good to excellent yields were obtained on many of the plots representing the major types of the alluvial forest soils of the district. Suitable strains of the Durango variety were developed and distributed for commercial growth in the district, and cultural methods such as the best time to plant, proper row and plant spacings, best height of plants for thinning and similar problems were investigated and reasonably satisfactory answers were obtained. With the occurrence of a season in which late planting rains and irregular mid-seasonal conditions were experienced, very poor yields were produced on most plots, many of which had been planted to cotton for several successive seasons with very satisfactory results. A repetition of such unsatisfactory yields in following seasons, in some of which the climatic conditions were suitable for the production of higher yields than were obtained, indicated that some major basic soil factor was involved. As the yields realized in the series of various crop rotations studied did not offer encouragement of any important improvement being obtained in this direction, various investigations were carried out on the different soils of the Research Station.

The results indicated that as a whole the soils were well supplied with available nitrogen, phosphate and potash. In the newer cultivations the balance between these plant foods appeared to be suitable for producing satisfactory yields of cotton when sufficient soil moisture was available at critical periods in the growth of the plants. In the older cultivations, irrespective of the previous cropping history, there was a marked tendency to produce substantially more nitrates, both under field conditions and in soil incubation tests. It was also found that the permeability of the zone of ploughing had been seriously impaired in the older cultivations.

Investigations were then started to ascertain the respective merits of newly broken up grassland and old cotton cultivations both on the Research Station and in the main cotton-growing districts.

The evidence obtained clearly indicated that substantial gains in favour of the new cultivations could usually be anticipated. It was decided, therefore, to test the value of re-established grassland on old cotton cultivations to restore the nitrate balance and permeability of the soils which existed in the first two or three seasons of cotton production following the breaking up of the native grassland. Rhodes grass (*Chloris gayana*), which is extensively sown in the cotton-growing districts, either in the ash of new burns of fallen scrub or towards the end of the wet season in the cotton crops planted in the first season of the burning of the scrub area, was therefore sown on old cotton cultivations on the Research Station. After two seasons of growth of the resultant grass the land was ploughed and planted to cotton with very promising results.

Since then much of the annual programme at the Research Station has been centred around the investigation of various aspects of the use of the Rhodes grass–cotton rotation. Considerable progress has been made in our knowledge of the value of this rotation on the soils of the Research Station. The Field Officers located in the main cotton-growing districts have also made progress in ascertaining the merits of this rotation on the major soil types of their areas, and each season an increasing number of farmers are practising it with good results in their yields of cotton and in pasture improvement. On most dairy farms the pastures consist of mainly single species of grass, which, in conjunction with over-grazing during very dry seasons, cause such a decline in productivity and quality after a few years that renovation of the pastures is highly desirable at various intervals depending on the fertility of the soil. Investigations have indicated that the most efficient and economical form of renovation is to plough out the grassland and grow cotton for two or three seasons. During this period the cultivation operations assist the micro-organisms to decompose the organic matter in the soil sufficiently to allow ample nitrification to occur in the following three or four seasons. The soil is then in a condition to produce excellent yields of Rhodes grass of superior quality. The use of the rotation also inproves the permeability of the soil during the period of cotton-growing, thus increasing the efficiency of the trapping of storm rains. This reduces soil erosion on slopes when the soil is cultivated, and during the period when the grass is growing soil loss is practically eliminated. The answers are not available, however, to many questions, and much work still remains to be done before a full understanding of them can be expected.

Among the problems to be solved for each of the soil types in the main cotton-growing districts may be listed the following :—

(*a*) The best time of ploughing the grassland for growing cotton ; (*b*) the relative effect of mid-seasonal and late autumn ploughing under of heavy growths of Rhodes grass on the rate of nitrification during the following years in which cotton may be grown ; (*c*) the number of successive seasons in which both Rhodes grass and cotton may be

satisfactorily grown in the grassland–cotton rotation; (*d*) the best variety of cotton to grow with the most suitable method of practising the Rhodes grass–cotton rotation.

Although it appears that a considerable reduction in losses caused by insect pests can usually be effected on many soils through the efficient use of the grassland–cotton rotation, in some seasons, especially when the delayed occurrence of the planting rains prevents the reasonably early establishment of the cotton crops, efficient methods of combating insect attacks are required. The development of jassid-resistant varieties is especially important and promising progress has been made in this respect. Encouraging results have also been obtained in recent seasons in the control of the corn ear worm. Much more work will be required, however, before the control of this world-wide difficult pest is achieved.

The run of dry springs and the intensely hot dry conditions in January which have been experienced in the last few seasons have focused attention on the merits of growing cotton with individually owned supplementary irrigation facilities installed on streams or in shallow wells containing ample supplies of water. Much work will be required before the full possibilities of this form of cotton-growing are understood. The ability to obtain an early planting by means of irrigation during a dry spring is undoubtedly valuable. The irregular occurrence of the rainfall during December and January may make it extremely difficult, however, to obtain the fullest possible yields which a soil is capable of producing under irrigation facilities alone. Although promising results have been realized during the last two seasons in which fairly dry conditions in December have been experienced, investigations over several years will be needed to enable the effect of other types of seasons to be studied.

Summarizing, it may be stated that the development of the grassland–cotton rotation has markedly increased the prospects of obtaining satisfactory yields of rain-grown cotton under a wide range of climatic and soil conditions. As many cotton growers also engage in dairying, the use of this rotation is advantageous for their dairying operations. When the double value of the rotation is appreciated more fully by the dairy-farmers in the older districts where cotton-growing declined after a few years of trial, it is anticipated that the renewed interest in the crop which will occur there will result in a considerable expansion in cotton production. Based on the yields which have been obtained in the irrigation experiments conducted at the Research Station, and in the best of the farmer demonstrational trials, it would appear that the growing of cotton under individually owned supplementary irrigation facilities may be fairly profitable where such irrigation can be economically applied at critical periods in the growth of the cotton crop. Extensive development of small-scale storage of supplies of water by means of weirs constructed on the various streams and rivers in the districts will be required, however, before any substantial acreage of cotton can be grown by such means.

PROGRESS REPORT FOR THE SEASON 1941-42.

Introduction.

This report on the investigations conducted at the Cotton Research Station has been prepared from the reports submitted by Mr. S. Marriott, Assistant Research Officer, who was responsible for the operations connected with cotton breeding and genetics, and Mr. W. A. R. Cowdry, Acting Manager of the Research Station, who reported on the experiments carried out under dry farming and irrigation conditions. Mr. Cowdry was assisted by Mr. N. Adams, who was responsible for the conduct of the irrigation investigations, Mr. R. George, who made a large number of soil moisture and nitrate determinations in connection with the season's programme of investigations, and Mr. W. J. Winchester, who carried out much of the routine observations in the experiments on the rain-grown cotton. Miss E. A. Goward, who has assisted Messrs. H. M. Finucan and P. McGovern (Assistant Research Officers, Biometry), for several seasons, supplied all the statistical analyses after mid-season, when these two officers obtained leave to join the Military Services. The appended entomological notes have been compiled from reports submitted by officers of the Entomological Section, Division of Plant Industry (Research).

The season's programme of work, as a whole, was carried out satisfactorily. Some curtailment of the detailed observations originally planned for several of the experiments was necessary through lack of staff replacement following on Mr. Cowdry's promotion to Acting Manager of the Research Station. The loss of two of the labouring staff who joined the Military Services also created difficulties connected with carrying out the cultural operations. The Staff is to be congratulated on bringing through, under very trying seasonal conditions, a heavy programme which has contributed considerable information towards solving the problems under investigation.

The experiments conducted at Biloela over a series of years have shown that oats and wheat for winter grazing and hay crops, and sorghum as a summer grain and fodder crop, should be included in the cropping programme of the farmers in the Callide Valley and adjacent interior districts. Accordingly, Dr. L. G. Miles, who has been engaged in maize breeding for several years in North Queensland, was transferred from the Bureau of Tropical Agriculture, South Johnstone, to Biloela, at the start of this season, to take over the investigations in cereals and sorghum, and to start a programme of varietal improvement of the latter crop. Owing to the extreme urgency of increasing cotton production in this State following on Japan's entry into the War, however, Dr. Miles will largely concentrate on cotton improvement work in the Callide Valley centres during the War, in order that the officer previously responsible for this activity can engage more extensively in district advisory duties.

Following on the eradication of prickly pear in the extensive Northern Darling Downs district, dairying and wheat-growing have developed markedly. Cotton has also been grown to some extent in

recent years and as there appear to be possibilities of including this crop in a satisfactory rotation on several of the major soil types of the district, Mr. L. M. Hodge was transferred there from Biloela in October, as Senior Instructor in Cotton Culture.

The opportunity is taken to place on record an appreciation of the excellent assistance Mr. Hodge has contributed towards the development of the Research Station. Starting as Manager in August, 1926, when the Research Station was in the preliminary stages of development, Mr. Hodge has always entered enthusiastically into his duties relating not only to cotton but to a wide range of other crops which have been studied at that centre. Over the years he has contributed largely to the present understanding of the possibilities of growing wheat, oats, sorghum, maize and cowpeas, in rotations with cotton in the Callide Valley. In addition, his assistance in the actual development of the Research Station has been of inestimable value.

Meteorology.

The climatic conditions experienced during the season were most variable and as a whole placed a big premium on the practice of proper cultural methods. Most of the experiments yielded satisfactorily, however, considering the season, and the results obtained will make definite contributions towards solving the problems under investigation.

The splendid rains experienced early in the previous June provided good subsoil moisture to a depth of at least two feet, but the rest of the winter and the early spring were exceedingly dry. However, rainfall above the normal in October allowed most of the Research Station's cotton acreage to be planted in that month. Further rainfall at mid-November enabled the planting of the rest of the area to be completed, thus giving the experiments the best start for several years.

From then on, with the exception of a rain group yielding 1·16 inches in the first week in December, hot dry conditions mostly ruled until January 28th, when a four-day rain yielding 4·35 inches was experienced which revived the areas of rain-grown cotton, all of which were reacting seriously to the severe conditions that they had experienced. A further rain group of five days started on February 8th during which 11·40 inches of rain was received and this caused serious flooding of much of the lower alluvial flats in the district. Farmers suffered some loss of livestock and fully 1,000 acres of cotton were washed away, while most of the early-opened crops of bolls were destroyed. Good average rainfall interspersed with rather long hot, dry periods, was experienced for the rest of the season.

The seasonal summary of rainfall in comparison with the means for similar periods in the seasons 1924–42, is included to indicate the moisture conditions under which the crop was grown.

	June–Sept. inclusive	*Oct.–Dec. inclusive*	*Jan.–March inclusive*	*April–May inclusive*	*Seasonal Total*	*No. wet days*
	ins.	*ins.*	*ins.*	*ins.*	*ins.*	
1941–42	3·95	5·56	19·31	4·98	33·80	63
Previous Mean	3·69	8·13	12·06	3·67	27·55	75·8

An interesting feature of the total 1941–42 rainfall is that while it was higher than the mean for the period during which the Research Station has been in existence, and markedly above the total of each of the immediately preceding three seasons, much of the rainfall was of a penetrating type as shown by the following table :—

Class	*Total rainfall in inches*	*Rate per hour*	*Percentage of seasonal total*
Torrential (over 0·75 inches per hour)	7·55	1·32	23·7
Medium (0·41 to 0·75 inches per hour)	7·34	0·53	23·1
Slow (0 to 0·41 inches per hour)	16·88	0·11	53·2

The percentage of the torrential class of rainfall for the three preceding seasons was 35, 43 and 41·8 respectively.

The mean maximum temperatures were mostly above the monthly means for the period 1926–42, with the exception of February, the heavy rainfall for that month being accompanied by cooler day temperatures—the daily mean being 4·3° F. below the mean for that month during the existence of the Research Station. January, with a daily mean of 95·9° F., was 4·3° F. above the mean for that month.

The minimum temperatures during the growing period were mostly normal except in the autumn, the daily means for April, May and June being 5·8, 2·4 and 4·9° F. respectively above the means for those months. The combination of day temperatures slightly above normal and the warmer nights in the autumn, in conjunction with the ample soil moisture, allowed the development of a splendid top crop on many experiments. As the first killing frosts did not occur until July 26th, this crop matured and markedly increased the total yields produced in many of the areas.

Genetics and Breeding.

It is possible to report progress for the 1941–42 season in the jassid-resistant cotton breeding programme, despite the most unusual growing conditions experienced.

There were nine plots in the project for the season. The detailed breeding plot contained strains of Miller, U.4, Cambodia, Rhodesian material, Punjab-American cottons, Ferguson (ex Trinidad), and a large number of hybrids. Cuttings made from backcrosses combining resistance with adequate boll and lint characters, carried through the winter in a site above severe frost levels and then planted in the regular breeding area in the spring, proved entirely satisfactory, setting a very large crop. This procedure will be continued in future seasons. New material produced on the Research Station, including further generations of backcrosses, will go into outlying breeding plots in the coming season.

Other plots included an increase of III–26–0, a pure Miller strain discussed in previous reports, from which further re-selections were made, while a special bulk selection from a commercial stock of

Miller 41 showed signs of possessing about 20 per cent. better resistance than other Miller strains. Arrangements have been made to multiply this strain, now known as 41.J, in the 1942–43 season when about 100 acres will be planted in areas subject to jassid attack. If this strain continues to retain its degree of resistance to jassid, it will prove a valuable cotton until other better strains are available for the grower.

Four isolated breeding plots, two of hybrids and two of Miller selections, yielded fresh jassid-resistant selections of which over 180 survived laboratory tests for boll and lint characters.

A simple demonstration plot (replications being impossible owing to shortage of seed) consisting of 5 second generation selections from (Miller × U.4) × Miller backcrosses and III–26–0 was planted alongside a cotton varietal trial at Monto in the Upper Burnett, an adjacent district where jassids frequently cause serious losses on certain fertile scrub soils. Throughout the season the jassid-resistant material was showing markedly less jassid symptoms and at mid-season was carrying a lower jassid population than the commercial varieties, which included Miller 41, in the adjoining trial. III–26–0 exhibited good uniformity for this character, while the backcrosses were showing some segregation. The jassid-resistant strains carried a better crop than any of the varieties in the trial, but the absence of an adequate experimental design makes it dangerous to draw conclusions therefrom.

The Cliett selections mentioned in last year's report were planted out, but failed to survive the severe environmental conditions on the isolated farm on which they were grown. The work will be repeated in the coming season.

Strain Tests.—The testing of advanced strains of varieties suitable for the soils on the Research Station was continued. In the Miller variety a four-strain, six-replicated, randomized experiment failed to yield significant differences although the actual yields obtained from the three newer strains exceeded the bulk stock by 40 or more lb. of seed cotton per acre, with the leading strain producing at the rate of 1,096 lb. per acre. As the lint percentages of all of the strains were approximately the same, it would appear that the productivity of each of the new strains under the conditions experienced was at least as good as the parent stock. As commercial plantings in this and the previous season also appeared to confirm this conclusion, the two most attractive new strains which are markedly more uniform in plant and fibre characters than the parent, will be increased to replace the old commercial stock. Another strain test will be included in the 1942–43 programme, however, prior to making a final decision regarding the relative suitability of these two strains to replace the parent stock.

The testing of strains of the Triumph variety was intensified this season and embraced the following strains :—ten of the most promising of the newer strains, the main commercial strain, and two of the most advanced improved strains in a six-replication experiment. All the strains reacted severely to the dry, hot conditions experienced in

January, there being only a narrow range in the high percentages of forms shed. Rather marked differences were obtained, however, between the strains in the number per plant of nodes, flowers produced and green bolls borne up to January 16th. Following the January–February rains, a good recovery in growth was made by all strains with the result that there were no significant differences in the total number of flowers produced for the latter half of the season.

The mean yield of the first picking of these Triumph strains was only 315 lb. seed cotton per acre, thus reflecting the effect of the severe weather in January on such an open type, quick maturing variety. F (ratio of mean squares) for strains was highly significant, however, the yields ranging from 250 to 407 lb. seed cotton per acre. Much better yields were obtained in the second picking, the mean of which was 547 lb. seed cotton per acre. F for strains was also highly significant for this picking with a range from 359 to 733 lb. seed cotton per acre, and the total yields with a range from 639 to 1,100 lb. seed cotton per acre. There was a definite tendency for the order of total yield to be closely correlated with the order of the yields of the second picking ($r = \cdot 972$) thus indicating a marked diversity in ability to make a quick recovery after stress conditions at mid-season. Apparently a good range of types with pronounced differences in plant structure, rate of flowering, resistance to stress conditions and yielding ability has been isolated which should eventually yield very useful strains for the more fertile and better moisture-holding soils in the main cotton-growing districts of this State.

Agronomic and Varietal Experiments.

As reported for the 1940–41 season, an increasing amount of attention is now being given to varietal testing in the programme of investigations for the Research Station. The work carried out in the 1941–42 season largely followed along the lines of the previous season and consisted of the following experiments :—

Main Varietal Test (*D.12–14*).—A 12×6 randomized block experiment embracing the same varieties as were tested last season. The daily flower counts gave clear-cut evidence of the ability of the recognized early flowering varieties to produce outstandingly more flowers during the first four weeks of flower opening. The hot, dry period in January, while admittedly exceptionally severe, most seriously affected those varieties which had produced the greater number of squares and flowers up to then—the flowering graphs of the leading varieties in the first four weeks declining the most rapidly to practically nil during the heat wave of the next three weeks. Detailed plant observations made towards the end of this hot period showed that the varieties which flowered most heavily early in the season had shed a higher percentage of their forms developed to that period, although in all varieties heavy losses had occurred. On the occurrence of the January–February rains, however, the varieties which had produced the most flowers in the first four weeks, made a markedly quick recovery and led in flower production for the rest of

the season. Although the slower flowering varieties during the first four weeks tended to withstand the stress conditions better, the slower recovery made by these varieties resulted in their total flowering for the season being markedly less than that of the quicker flowering types.

The first picking, consisting almost wholly of prematurely opened bolls, the cotton of which had been exposed to the heavy February rains, ranged from 128 to 209 lb. seed cotton per acre without any consistent trends. The second picking, however, which ranged from 675 to 1,092 lb. seed cotton per acre, was in keeping with the amount of flowering after these rains. Once again there was a high degree of correlation ($r = \cdot 945$) between the yields of the second picking and the total production for the season. F for varieties was highly significant, with the quick flowering Triumph outyielding all others except Rowden 40–6–F.3, one of the newer varieties under test, which appears to have possibilities in some districts.

Last season, with planting at the end of November, the varieties producing the higher number of flowers for the season and particularly in the fourth to sixth week inclusive of flowering, yielded better than the slower and lighter flowering types. This season the first seven weeks' flowering did not play an important part in the total yields obtained, but the quickest flowering types after the February rains produced the most cotton. From the standpoint of yield, it does appear, therefore, that a quick maturing variety like Triumph is desirable in the Callide Valley. When early planted, however, such a variety may react very severely to stress conditions experienced at mid-season, if the crop borne then is too much for the moisture supply available. Not only may a considerable loss of squares and small bolls result in such circumstances, but the quality of the fibre in the bolls retained will be adversely affected. The slightly earlier than medium seasoned types producing full-bodied cotton appear to offer, on most soils in this district, the best possibilities of obtaining satisfactory yields of fibre of good quality under a wide range of seasons, except possibly in very late plantings. As the Miller variety is of this type, and has given good results over a range of seasons when grown commercially under proper cultural conditions, it would appear that its selection as the main variety for most of the soils of the Callide Valley was a sound one, especially as it produces big bolls that are easily picked.

Varietal Tests for Mechanical Harvesting Trial.—These two experiments are a repetition of the investigations reported last season, with the exception that one experiment followed sorghum on more fertile soil (D.18–21) than the C.12–17 site of last season, and the I.5–10 site this season was in the second cultivation after grassland.

Owing to the extremely leafy growth which developed in D.18–21 after the heavy rains in February, it was obvious that the mechanical harvester could not pick the first opened bolls, so the crop was hand-picked. F for varieties was not significant, although once again the early flowering types outyielded the very slow flowering varieties,

the yields ranging from 497 to 622 lb. seed cotton per acre. During July this experiment was machine-harvested, with one row in each plot of each variety hand-picked as a check on the efficiency of the machine. The second series of hand-picked yields ranged from 518 lb. to 702 lb. seed cotton per acre, but owing to the vegetative type of plant produced, the machine could pick only from 63 to 70 per cent. of the crop according to variety.

The grading reports stated that without exception, the samples of machine-harvested cotton were less spotted than the hand-picked, indicating, as last season, that the machine rejected the diseased, badly-opened locks. Unfortunately the machine-harvested cotton again contained an excess of small " pepper " pieces of leaf which were mixed with the fibres so tightly that only slight elimination of them could be effected with the cleaning machinery in the ginning operations.

The hand-picked cotton of all the varieties was graded Middling Light Spotted, and the machine-harvested cotton Strict Low Middling, excepting that of Miller. Owing to the big locks and full-bodied fibres of this variety, the pepper leaf was not so firmly pressed into the fibres and the machine-harvested cotton was graded Middling (low side of grade). F for varieties was not significant for either of the hand pickings or the total yield, although the total yields ranged from 1,015 to 1,312 lb. seed cotton per acre with Triumph the leading variety. Once again these was a high degree of correlation between the second picking and the total yield.

The site of the I.5–10 experiment contains two soil types, one of low moisture-holding capacity and fertility, the other high in both respects. The area was selected so that the effect of the combination of soil type and seasonal conditions on the suitability of the plants for machine-harvesting could be studied. The hot, dry conditions in January were too severe for the plantings on the lighter soils, while the February floods over the heavier soils caused serious loss of crop ; the experiment thus yielded under 500 lb. seed cotton per acre and therefore is not discussed in detail.

The conclusions drawn from the two seasons' trials are that the machine has definite possibilities of working reasonably satisfactorily subject to the following conditions :—plants should be relatively free from vegetative branches and axillary leafage ; bolls should be large and well opened yet should twist the cotton sufficiently to remove it from the bolls and hold it until released at the proper time ; the cultivation should be free of all materials, grass and weeds, otherwise serious damage may be caused as they pass through the lower parts of the harvesting apparatus. Fibres with staple $1\frac{1}{16}$ inch or longer and of medium to soft character may tend to " rope " somewhat on account of the twisting imparted by the spindles of the machine when pulling the cotton from the boll.

Varietal Tests on Different Ages of Cultivation.—The same varieties were tested in this experiment as in previous seasons. Owing to

shortage of staff, only two blocks of each of the six varieties, instead of the usual Latin Square were planted on each age of cultivation. The ages of cultivation consisted of the first and third year of cotton following three years of Rhodes grass, and cotton in the 18th, 13th, 10th and 4th year of consecutive cotton crops from virgin forest grassland. No flower counts were made in this experiment, but observations at mid-January indicated that the third year of cotton following Rhodes grass had the best crop prospects, while the plants in the first year following Rhodes grass, which were of rather a smallish structure with light yellowish green leaves had the least crop. Following the February rains, good growth was made in all areas except in the first year after Rhodes grass. The better appearance at mid-January of the crop in the third year following Rhodes grass was reflected in the total yields obtained, each variety producing substantially more cotton in that series than on any of the other ages of cultivation, with Triumph the heaviest yielding. Conversely, the first year after Rhodes grass produced the lowest yields for each variety, with Triumph the second lowest yielding. F for the interaction between varieties and ages of cultivation was not significant. F for varietal totals over all ages of cultivation was highly significant, however, and once again the early flowering types outyielded the later ones. The difference in the order of merit of Triumph in the high and low yielding cultivations confirms observations of last and previous seasons, that the early flowering varieties of a more open habit of growth when planted on late ploughed cultivations in the first season out of grassland, may, in seasons experiencing dry conditions in November and December, be adversely affected by a deficiency of nitrates.

Fortnightly soil moisture and nitrate determinations were carried out in J.14—10th year of continuous cotton after virgin grassland, J.15—the fourth year of continuous cotton after virgin grassland, and J.16—the first year of cotton following three years of Rhodes grass after the first three years of cotton from virgin grassland.

Moisture determinations made to a depth of 4 feet at mid-November showed no significant differences between ages of cultivation in the 24- to 48-inch zones, the limit of penetration of the early June rains being approximately 24 inches. Prior to the end of the January rains there were no significant differences in any zone sampled, but following 4·87 inches of "medium intensity" rainfall, the mean penetrations were J.14—22 inches, J.15—24 inches, and J.16—28 inches, with J.16 significantly greater than J.14 at both the 24-inch and 30-inch depths. Compared with the determinations of mid-November, the only significant gain was at 24 inches in J.16, thus indicating that 4·87 inches of such a type of rain barely replenished to this depth the moisure lost in the older cultivations, but in J.16 it not only replenished but increased the moisture at this depth, thereby indicating greater permeability in the upper layers of the newer cultivation. After the flood rains there were no significant differences between ages of cultivation, a good supply of moisture having penetrated 4 feet 3 inches to 6 feet in each area.

Following the February rains, the plants in J.16 did not grow so rapidly as did those in J.14 and 15, and as a result, J.16 contained more moisture than either of the other two areas. The rains of March (1·36 and 1·03 inches) and April (1·43 and 1·14 inches) penetrated only 6·7 inches and were barely sufficient to maintain steady plant growth. The May 27th rain of 2·37 inches penetrated about 12 inches in J.14 and 15, and 18 inches in a few plots, whereas in J.16, it reached from 14 to 15 inches in the already slightly wetter soil.

The season's studies would appear to indicate that the mean penetration of an inch of rain of the " soaking " type into a soil with a moisture equivalent of around 26 per cent., approached 5 inches in the two older cultivations and nearly 6 inches in the newer cultivation when the top 6 inches of soil was practically at wilting point. When the surface soil was in a moist condition the penetration was increased slightly.

Fortnightly determinations of nitrogen in the first, second and third 6-inch levels at the sites used for the moisture sampling indicated that from October to mid-December there was a slight rise in the nitrate content of J.14 and 15 in the first 6 inches of soil, the mean maximum content ranging around 10 parts per million early in December. The dry conditions of November and December resulted in the plants rapidly using the moisture in the first 18 inches of soil during the heat wave in the latter part of December and the first four weeks of January with an accompanying drain on the nitrates present. During this period the mean nitrate readings in the upper 6 inches of soil in J.16 did not exceed 4·5 p.p.m. The soaking rains at the end of January leached the nitrates in all three cultivations down to the 18-inch level, while the heavy rains of February leached them below this level. For the rest of the season the mean readings at any level in either J.14 or J.15 did not exceed 3 p.p.m., while the mean reading of any level at any period in J.16 did not reach 1 p.p.m.

Throughout the November–December period there was a marked difference between the three areas in regard to the colour of the leaves and the size and general vigour of growth of the plants. The plants on J.14 and 15 were fairly similar and of a satisfactory type, but in J.16 there was a general indication of nitrate deficiency. Following on the February rains nitrate production appeared to be ample for the plants in J.14 and 15, but apparently insufficient in J.16, as judged by the restricted growth of the plants and the low nitrate readings obtained for the rest of the season.

Combined Varietal Test and Rotational Trial.—The work reported upon last season under this heading was continued along the same lines this season. With the earlier planting and the long frost-free autumn, there was no significant difference between the mean yield per acre of Triumph (855 lb. seed cotton) and Miller (905 lb. seed cotton) over all rotations, although Miller actually outyielded Triumph in all but three out of the ten comparisons. Under the seasonal

conditions experienced, cotton following maize tended to outyield cotton following cotton, sudan grass and sweet sorghum—a gain of 257 lb. seed cotton per acre being obtained over the latter crop. This tendency for cotton following maize to outyield cotton following sweet sorghum has occurred in 7 out of 10 years of comparisons. During this period of comparing the merits of cotton following cotton and cotton following maize, sweet sorghum and giant setaria, no significant differences between mean yields have been obtained, whether the yields were high or low. For the second year, cotton following three years of Rhodes grass produced the highest yield of any of the rotations, although the gain was not as great as is usually obtained in seasons of high nitrate production.

Rhodes Grass–Cotton Rotation.—The testing of the value of this rotation was continued along the lines reported last season in the following experiments :—

E.10–16.—It was not possible to carry out flower counting in this experiment, but fortnightly nitrate and moisture determinations were made in E.13 (continuous annually planted cotton) and E.10 (second year after three years of Rhodes grass). The moisture equivalent of the soils in this series of plots ranges around 27·5 per cent. in the first two feet and somewhat higher in the third foot.

At planting time the soil was well moistened in both areas—approaching field capacity at 24 inches. From July to planting time, E.13 was significantly higher than E.10 in the 18 to 24-inch level. Ample moisture was present during November and early December, but during the heat wave the good growth of the plants in both areas seriously reduced the moisture content of the first 24 inches of soil, the determinations in the 18- to 24-inch zone just prior to the rains at the end of January being 13 per cent. on the oven-dried soil. The end of January rain group penetrated through the 24-inch zone, increasing the moisture content to 21·2 per cent. in E.10 and 23·6 per cent. in E.13. These amounts were later reduced somewhat, but there was ample moisture in this zone for the rest of the season, with a tendency for the determinations in E.13 to exceed slightly those of E.10. The explanation of this result is not clear, except that comparisons of the moisture equivalents and sticky points of the first six inches of soil in these areas indicated E.13 to have a slightly higher moisture-holding capacity. The February rains penetrated a mean depth of 5 feet in E.10 and 4½ feet in E.13. Two rains (1·36 and 1·03 inches) separated by five days at mid-March penetrated 12 inches in both areas, but a storm of 1·36 inches in April penetrated only 4 inches in E.13 as compared with 5 inches in E.10, so that it would appear that the second year cultivation was slightly more permeable, but did not retain so much moisture in the first 24 inches of soil. It is possible, also, that the heavier yielding plants in E.10 may have utilized more moisture in the latter half of the season.

The nitrate content of the soil was significantly different throughout the season in each of the first four 6-inch zones. Starting

in July, the mean determinations of the first 6-inch zone in E.10 very slowly increased from 1·8 p.p.m. to 11·1 p.p.m. at the end of November after which, during the dry weather, the utilization of moisture reduced the content to 6 p.p.m. The February rains leached the nitrates through the first 24 inches and afterwards the determinations did not exceed 2 p.p.m. for the rest of the season in any zone. The nitrate content of the 18–24-inch zone in this area did not exceed 3 p.p.m. all the season.

The results in E.13 were in marked contrast. Starting with a mean content of 3·7 p.p.m. in the first six inches of soil, the value gradually rose to a mean of 11 p.p.m. until the planting rains occurred ; the nitrate content then increased rapidly, rising to a mean of 21·6 p.p.m. in this zone by the end of November and then dropping only slightly until the February rains leached most of the nitrates out of the first 18 inches.

For the rest of the season the nitrate content of the first 6-inch zone did not exceed 8 p.p.m. The 18–24-inch zones showed greater contrast between the two areas than did the first 6-inch zones. As a result of the soaking rains of March and then June in 1941, the nitrate content of the 18–24-inch zone in E.13 reached the extremely high reading of 35·7 p.p.m. in July, 1941. For the rest of the 1941–42 season it ranged irregularly from 26 to mostly 30 p.p.m., until the February rains caused a reduction to 22 p.p.m. From then on it slowly declined to 6 p.p.m. at the end of June, 1942.

The result of the difference in the nitrate content of the soils was clearly shown in the respective plant growths. Although the heights were comparable, the plants in E.10 were of a more open type, less leafy and had lighter coloured leaves. An interesting feature of the plant growth in these two areas was that during May and June there was much less loss of leaves from the plants in E.10 than in E.13 where nearly all the leaves were shed during this period. This suggests that possibly the plants in E.13, which had been grown in a soil of fairly high nitrogen content during most of their development, with a resultant excessive growth of leafage, could not satisfactorily adjust their nitrogen metabolism during the period of rapidly declining nitrification towards the end of the season when the crop of squares and bolls borne created a heavy demand on the nutrients taken up by the plants. The effect of a small supply of nitrates being available throughout the season was more pronounced in E.14 where, on a late plough-under of grassland in the first year following three years of Rhodes grass, the plants were much smaller than in E.10 and 13, and showed all the typical symptoms of nitrogen deficiency.

The yields of seed cotton per acre of the experiment are presented to show the effect of the interesting reactions of varieties on different ages of cultivation after Rhodes grass.

	Triumph	*Miller*	*Mean Yield*
E.13—cotton continuously	767	871	819
E.14—1st cotton after Rhodes grass	531	687	609
E.10—2nd cotton after Rhodes grass	1,177	991	1,084
E.16—3rd cotton after Rhodes grass	959	1,068	1,013

Once again in a season experiencing very dry conditions in late November, in December and in most of January, cotton following a winter ploughing-in of a big body of Rhodes grass has given definite evidence of a deficiency of nitrates restricting plant growth and reducing yield as compared with those obtained on old cultivations. In the second and third seasons after Rhodes grass, however, increased yields over old cultivations were obtained. Seasonal conditions appear to be an important factor in determining the respective merits of second and third year cotton after grassland. Last year, under conditions of late planting and a wet March, the second year after Rhodes grass greatly exceeded the third year. This year, with early planting and low nitrifying conditions during the period when the plants changed from the vegetative phase to the fruiting phase of development, very little difference in yields resulted, although the second year produced a slightly heavier crop. The yield in E.13 was markedly higher than is usually obtained on old cotton cultivations in this series of plots and reflects the beneficial effect of the relatively low nitrate content existing in the first foot of soil from mid-season onwards.

G.11–17.—This experiment was again laid down on the site of the experiment reported under this heading last season. The cotton was planted on November 3rd and although the soil is only moderately retentive of moisture, the date of planting resulted in the plants entering the hot, dry period in January with only a light crop and thus enabled them to withstand the stress conditions, especially on the area where Rhodes grass was ploughed in three seasons previously. The resultant yields showed a distinct difference in favour of the latter area—749 lb. seed cotton per acre as compared with 495 lb. on the old cotton cultivation.

In all three seasons of this experiment, gains have been obtained on the area previously under three years of Rhodes grass—namely 297 per cent. in the first season after Rhodes grass, 57 per cent. in the second and 51 per cent. this season—or a mean gain of 245 lb. seed cotton per acre over the three crops. This soil type, which was described under G.2–10 experiment in the last season's report, is capable of producing only fair yields and is fortunately a minor type in the district. The use of the Rhodes grass rotation over a series of years in conjunction with planting on the level contour under a strip crop method of farming appears, however, to offer possibilities of improvement.

I.11–14.—Observations made at different times have indicated that where Rhodes grass is closely grazed or burnt off prior to the ploughing-under of a three-year-old sod on fertile clay loam, the physical condition of the surface soil in the second or third season of cultivation may not be as permeable as is desirable, particularly on slopes. Accordingly it was decided to plough under in the autumn of 1940 a standing body of fully matured Rhodes grass about three feet tall in order to study the lasting effect of such a turn under on the permeability of the soil. Dry conditions prevailing through the late autumn and early winter caused the postponement of the ploughing

until finally an attempt was made in early August. It was found, however, after ploughing a few furrows, that the soil following the long dry autumn period was too hard to allow the turning under of such a body of grass. It was decided, therefore, to use the site during the 1940–41 and 1941–42 seasons for an experiment to test the relative merits of February and June ploughing-under of all the Rhodes grass present at the time of ploughing. The August, 1940, ploughed plots were included in the experiment to test the effect of an all-season fallow of the dead grass, and were re-ploughed at the time of the February ploughing. The area was accordingly mowed and left ungrazed in the following season so that good bodies of grass were present in the February, 1941, and June, 1941, ploughings. The February ploughing was done when a heavy body of grass was present that was just past a suitable stage for hay making ; the June ploughing when the grass was in a fully matured dry condition. Excellent rains in March and exceptionally good late May and June rainfall allowed very satisfactory turn unders of the grass to be obtained, the ploughed soil breaking down into a good seed bed after two disc harrowings and one cultipacking in September.

In view of the dry condition of the soil encountered in August, 1940, soil moisture determinations were started in April, 1941, to ascertain the consumption of soil moisture by Rhodes grass. Starting off with the first 6 inches of soil in all three treatments containing 25 per cent. of moisture on the oven-dried soil, and the third 6 inches of the August ploughing containing 26 per cent., with similar zones in the February and June areas having 22 and 23 per cent. respectively, very little difference was noted between the August and February ploughings for the rest of the period to planting time. In the plots which were not ploughed until June, however, the Rhodes grass rapidly reduced the moisture in the first 18 inches of soil and by mid-May the first 6 inches was approaching wilting point. Very good rains were then experienced which penetrated to 30–32 inches in the earlier ploughings and 26–28 in the grassland, which allowed a good turning under of the grass to be obtained.

The soil to a depth of 18 inches in all three treatments was wet to field capacity at planting time, but the greater permeability of the June-ploughed area was evidenced throughout the season during each rain group experienced, thus indicating a slower rate of decomposition of the organic matter incorporated into the soil by the ploughing operations.

The nitrate content of the first, second and third 6-inch zone in each treatment was determined fortnightly commencing in early November. The determinations in the August ploughing indicated that starting from a mean reading of 7·8 p.p.m., the contents of the first 6-inch zone rose to 12·4 p.p.m. by mid-December, after which the increased use of the moisture in this zone resulted in a rapid decrease in the readings until the February rains leached the first 18 inches so severely that none over 2 p.p.m. was obtained for the rest of the season. At no

stage during the whole season did the value in the third 6-inch zone of this area exceed 3·5 p.p.m. The readings in the February ploughed areas roughly paralleled those of the August ploughing, but on a lower scale, the 6-inch zone increasing from 4·3 p.p.m. to 7·5 p.p.m. and not exceeding 1·5 p.p.m. after February, with the third zone not exceeding 2·6 p.p.m. all the season. The determinations in the June ploughing gave definite evidence of the slowness of nitrification of such a big body of ploughed-in grass during a dry November and December, the readings in the first 6 inches not exceeding 2·9 p.p.m. all the season, with many samples in the lower zone giving nil readings.

The growth of the plants throughout the season clearly reflected the nitrate content of the first 18 inches of soil in each date of ploughing. Very little difference was noted, however, between the plants on the earlier ploughings—the plants being taller, of bigger structure generally and with greener leaves compared with those on the June-ploughed plots. They were not of the typical vegetative type that the Miller variety develops on old cotton cultivations on the Research Station. No flower counts were made, but the final yields obtained (August, 827 lb. seed cotton per acre ; February, 787 lb. ; and June, 369 lb.) reasonably represent the respective rates of flowering. The nitrate determinations indicate that the rate of nitrification prior to the floods was exceedingly slow under the dry conditions ruling, and support the contention that the June ploughing-in of a heavy body of old standing grass in E.14 and J.16–18, inhibited nitrification to such an extent as adversely to affect plant growth and yields. It is possible that in a season experiencing a wet November, December and January, a more satisfactory type of plant might result from the greater amount of nitrification occurring under such conditions. It would appear, however, that where a large body of grass is to be ploughed under, it is advisable to plough in late February when the soil is sufficiently moist to allow the operation to be done well. Not only will a better supply of nitrates then be available for the following crop of cotton, but in most seasons the killing of the grass in February will help to conserve the soil moisture to a satisfactory depth and thus provide the following cotton crop with a moisture reserve during stress periods experienced at mid-season.

Row and Plant Spacing Experiment.—This experiment, which tested last season the merits of $4\frac{1}{2}$ and $3\frac{1}{2}$ feet row spacing combined with 1 and 2 feet single-plant spacing in the Miller variety, was enlarged this season to include the effect of such spacings in the Triumph, New Boykin and Miller varieties. Triumph has a slender, somewhat open habit of growth, and produces the most flowers of the three varieties ; New Boykin usually produces more flowers than Miller and is about intermediate between Triumph and Miller in plant type and drought resistance ; Miller is a fairly coarse growing type with a pronounced tendency to produce several vegetative branches when grown on very fertile old cotton cultivations.

Planted on October 15th, all varieties were showing the effect of the dry conditions by the end of December. A classification of the

appearance of the various combinations of treatments indicated that as a whole Triumph had reacted much more severely than either New Boykin or Miller, and that the latter had suffered less than New Boykin. It was also very obvious that while 4½ feet row spacing in either plant spacing had enabled all varieties to withstand the conditions better than 3½ feet row spacing, the greatest benefit had been obtained by spacing the plants 2 feet apart instead of 1 foot.

The flower counts nicely reflected the reactions of the various treatments to the seasonal conditions experienced. During the first four weeks the following significant differences were obtained :— Triumph exceeded the other two varieties, between which there was no significant difference ; 3½ feet row spacing was better than 4½ feet, while 1 foot plant spacing was better than 2 feet. During the next three weeks, which reflected the effect of the stress conditions experienced, the only significant difference obtained was that 2 feet plant spacing was better than 1 foot. In the three weeks of flower counting after flowering started following the February rains, the Triumph variety over all treatments significantly produced the most flowers, while 3½ feet row spacing was significantly better than 4½ feet row spacing in both plant spacings.

The yields of the first picking of all treatments clearly reflect the effect of the adverse conditions experienced in December and January, the mean yield being only 256 lb. seed cotton per acre. The following significant differences in yields were obtained in this picking :— Triumph and Miller exceeded New Boykin over all row and plant spacings, while 2 feet plant spacing exceeded 1 foot over all combinations, except in New Boykin where there was no significant difference.

The yields of the second picking reflected the better growing conditions after the mid-season rains, the mean yield for all treatments being 851 lb. seed cotton per acre. The following significant differences in yields were obtained :—1 foot plant spacing exceeded 2 feet, and 3½ feet row spacing was better than 4½ feet. Although no significant differences were obtained between the yields of the varieties over all treatments, the order of actual yields realized was Triumph, New Boykin and Miller, Triumph producing 76 lb. seed cotton per acre more than Miller.

Although the mean total yield of all treatments for the season was 1,107 lb. seed cotton per acre, the seasonal conditions had such a levelling effect that the only significant difference in yields obtained was that between 3½ and 4½ feet row spacing—106 lb. seed cotton per acre in favour of the closer spacing.

Although the use of 3½ feet instead of 4½ feet row spacing would increase the row footage per acre by 28 per cent. with an accompanying similar increase in the thinning and cultivating costs, the net return obtained from a gain in yield of 106 lb. of seed cotton per acre at the present prices for cotton, would be sufficiently attractive to warrant

the use of this closer spacing if such a gain in yield could be reliably anticipated each season. In the Miller variety in the dry 1940–41 season, a greater gain than this was obtained. Past experience has indicated, however, that in seasons with a wet December and January, there is a definite tendency to promote rank growth of plants on fertile soils, and if row spacings of less than 4½ feet or possibly 4 feet are practised, the resultant excessive development of shade that accompanies the rank growth of plant is conducive to losses occurring through the incidence of boll rots and insect attack. It appears doubtful, therefore, if it is advisable to use the 3½ feet row spacing on soils where excessively rank growth of plant will occur. On soils where a fairly suitable type of plant for machine-harvesting can normally be grown, the use of the 3½ feet row spacing in most seasons should not reduce yields.

Irrigation Investigations.

The programme of investigations conducted on the irrigation area consisted of a repetition of the previous season's work, with the age of cultivation of the area being one year older than last season.

Effects of Supplementary Irrigation.—Irrigated plots were planted on October 11th, following the spray application of 3 acre-inches of pre-planting watering. On October 14th the occurrence of 1·29 inches of rain provided suitable conditions for obtaining an excellent stand in both treatments.

During the hot dry period in the latter half of December, the plants used all of the available moisture in the first foot of soil and nearly all in the second foot in the irrigation plots although there was 19 per cent. of moisture in the third foot, which was practically the same amount as at planting time—thus indicating that the tap roots had not penetrated thoroughly into this zone. In the companionate raingrown plots, the moisture was practically exhausted in the first two feet of soil and down to 15 per cent. in the third foot zone. Three acre-inches of spray irrigation were then applied to the irrigation plots which promoted good development of the plants. The dry conditions during January caused such a rapid use of this moisture that another 3 acre-inch application was required on January 21st. The surface soil was very hard and dry by then and an average penetration of only 14 inches was obtained with this irrigation. It is possible, however, that under the hot and somewhat windy conditions evaporation may have been sufficiently heavy to reduce the efficiency of this application as compared with the moisture penetrations obtained with similar applications under conditions of less stress.

The heavy February rainfall caused the Callide Creek to back up over the area, and although water stood on the land for several days, a significant gain in moisture content was obtained only in the first 5 feet of soil. No further irrigations were required. By April 21st, however, the moisture content in the first 4 feet of soil had been

significantly lowered, thus indicating the limit of root penetration, as the moisture content of the 5th foot of soil remained constant for the rest of the season.

Based on the observations made during the two seasons of irrigation investigations conducted at the Research Station, in such a soil type as the site of this portion of the irrigation area (moisture equivalent first foot—27, second foot—29, third and fourth feet—30, and fifth and sixth feet—28), a 3 acre-inch spray irrigation can be expected to penetrate about 18 inches when the soil is in need of irrigation to maintain the cotton plant. This average penetration of approximately 6 inches of soil per inch of water applied compares with a penetration of 5 inches in old cultivation and nearly 6 inches in new cultivation, for 1 inch of rainfall.

Fortnightly determinations made throughout the season failed to demonstrate any significant differences in the nitrate contents of the two series of plots—the mean readings being very low. Ample nitrification appeared to have occurred, however, for at no period did the plants indicate that there was any insufficiency of nitrates in the soil.

The growth of the plants reflected the moisture content of the soil. Excellent development of plant structure occurred in both treatments until the effect of the long dry period operated. During the first three weeks of flower counting no significant differences were obtained, but from thence on the flowering in the non-irrigation areas declined rapidly to zero by January 25th and remained there for three weeks. Although the flowering in the irrigation areas also declined under the extreme stress conditions during the first half of January, it was very obvious that square production was being maintained sufficiently to provide flowering as soon as the very wet cloudy period at mid-February ceased. It was not until mid-March that the flowering in the non-irrigation areas equalled that of the irrigation areas, after which date both treatments flowered alike.

The yields obtained clearly indicated the value of irrigation facilities under the seasonal conditions experienced—the non-irrigation areas producing at the rate of 564 lb. seed cotton per acre and the irrigation areas 1,721 lb.—a gain of 1,157 lb. seed cotton per acre for the 9 acre-inches of irrigation water applied.

3 acre-inch versus 6 acre-inch pre-planting Spray Irrigation.—This experiment was not planted until October 20th, a rain of 1·29 inches having delayed the pre-planting watering. The application of 6 acre-inches of water following this rain definitely saturated the surface soil to a puddled condition, which necessitated the pre-planting cultivation operations being delayed for several days before the seed bed could be prepared. During this period an appreciable amount of the moisture in the surface soil of the 6 acre-inch treated plots must have been lost through evaporation.

No significant differences occurred throughout the season in regard to either plant growth, flower production, yields, or time of requiring an irrigation. In view of the negative results from this experiment both last season and this season, it will not be repeated.

Spray versus Furrow Irrigation.—This experiment was planted at the end of October following a 3 acre-inch spray application and an equivalent amount of water applied in furrows ploughed adjacent to the sites of the rows where the cotton was to be planted. Plant growth was reasonably comparable throughout the season and water was required equally when further 3 acre-inch irrigations were applied at the end of December and on January 26th.

A significant difference was obtained in the first picking in favour of the furrow method of application, but nearly as great a difference in favour of the spray method resulted in the second picking, the total yields of the two treatments for the season thus being nearly equal.

Although practically no differences between the yields of the two methods of application were obtained both last season and this, it is believed that the furrow method, where the uniformity of the slope of the land is suitable for the use of this method, has much to commend it. Where the land is furrowed out properly, less labour is required to apply the water at each irrigation, no spray equipment is required and on very heavy soils deeper penetration of the water is obtained. Most of the land on which supplementary irrigation will be practised in the main cotton-growing districts will not be suitable for furrow irrigation without considerable expenditure being incurred in grading it, and this experiment will be discontinued.

Varietal Test.—The varieties that were reported upon last season were again tested on the same site which was in the third year of cultivation out of virgin grassland. Planted on October 10th following a 3 acre-inch pre-planting watering which was supplemented a week later by 1·29 inches of rainfall, the subsequent plant growth was excellent in all varieties and flowering started on December 8th. By December 22nd all varieties definitely required more moisture and a 3 acre-inch application of spray irrigation was therefore made. The combination of heavy flowering and severely hot, dry conditions following this watering caused a rapid exhaustion of the added moisture and by January 8th a further 3 acre-inches of water had to be applied. By January 27th all varieties required more moisture, which was fortunately supplied by the 4·85 inches of rainfall experienced at the end of that month. Excellent plant development followed the February rains and the resultant crop set during the hot, fairly dry weather occurring in March necessitated the application of a further 2 acre-inches of water on April 1st. A total of 11 acre-inches, including the pre-planting watering, was thus applied for the season.

Although a mean yield of 1,987 lb. seed cotton per acre was obtained as compared with 1,815 lb. last season, plant reaction during early January indicated that it would have been advisable to have

irrigated earlier in December. This irrigation would have prevented the decline in flowering that started on January 11th and continued until February 22nd, when at the end of a fortnight's cloudy weather flower production rose rapidly to the high level reached in December, thus giving a definite bi-modal flowering graph for all varieties.

The season illustrates the difficulties that may be encountered in endeavouring to obtain the maximum possible yields by added irrigation in a climate where copious rainfall may occur at any time during the growing period of the cotton crop. The mean December rainfall for the Research Station is 3·77 inches and normally most of this should occur during the period in this past season when the plants were rapidly setting such a crop of squares and bolls as to require additional moisture. Had the area been irrigated early in December, there was thus the possibility that the normal rainfall would occur following the watering. As the plants were still young enough to have made much vegetative growth after receiving irrigation and rainfall combined which might have totalled from 6 to 8 inches, the December watering was postponed (in the hope that rain would occur) until it was obvious that an irrigation had to be applied to prevent serious loss of crop. Some loss of squares occurred after this watering, thus indicating that an earlier application would have been advisable.

All varieties produced a better yield than last season, excepting Farm Relief—which was fourth in order of merit whereas it was the leading variety last season. F for varieties was significant, with Stoneville significantly out-yielding the rest at the rate of 2,206 lb. seed cotton per acre. As occurred last season, the bolls of this variety made a " pinched " growth during stress periods. Miller—2,029 lb., and New Mexico Acala—1,929 lb. seed cotton per acre both produced very big bolls that were easily picked and contained attractive full bodied cotton. As the latter variety produced longer fibre than Miller in both seasons and also out-yielded it last year, extensive tests of New Mexico Acala under supplementary irrigation will be made throughout the Callide Valley in the coming season.

Entomology.

The usual range of seedling pests did little damage to cotton crops in the Callide Valley but the tip worm, *Crocidosema plebiana*, was unusually abundant shortly before the crops required thinning. This insect, though known in other parts of the State as a pest of cotton, has not hitherto been of any consequence in the more important producing areas. In spite of terminal losses up to 30 per cent., it was still practicable to maintain a complete stand at the Research Station by judicious thinning. Early spring rains ensured an ample weed growth on which populations of the corn ear worm, *Heliothis obsoleta*, could build up to potentially dangerous levels. By early December when the bulk of the crop was squaring freely, egg-laying in the greater part of the Callide was such that serious losses were inevitable. Square

shedding followed and was accentuated by the dry, hot weather which occurred until late January. There was no recurrence of this pest during the remainder of the season, at least in the Callide. After the heavy rains of late January and February, the cotton looper, *Antarchaea chionosticta*, and the rough bollworm, *Earias huegeli*, were conspicuously active. For the most part, the former proved beneficial rather than harmful as the leaf destruction caused by it thinned out excessive foliage in the rather bushy plants and thus reduced the incidence of boll rots far below what might reasonably have been anticipated. The rough bollworm continued to be troublesome right through the latter half of the season and caused appreciable damage to the main crop for the year, which, owing to the unusual incidence of the rain, developed from squares borne by the plant from February onwards. Though the cotton jassid, *Empoasca maculata*, was quite common from February onwards, the damage caused by it was more than compensated by the abnormally high growth rate of the plants during the autumn and this pest was therefore seldom an important factor in reducing yields.

Investigational Work.—A three-row spraying machine designed by engineers of the Queensland Cotton Board for attachment to some of the commoner cultivation implements, was used in a " Student " test of the 1–1–6 lead arsenate-molasses spray recommended under some circumstances for corn ear worm control. Four sprays were applied in all during the December outbreak of this pest at times when egg counts indicated that a major infestation was either pending or in progress. The decision to spray or not to spray is based on a consideration of the number of eggs actually recorded in any one week and also on the upward or downward trend in the weekly readings. Significant increases in yield were obtained in the first pick from the sprayed plots which, of course, represents the crop that was being formed on the plant when the pest was active. No differences in yield occurred in the second pick. Records of the structural development of the crop give no confirmation to an earlier suggestion that treatment tends to disturb the metabolism of the plant and therefore reduces its fruiting possibilities should no outbreak of corn ear worm occur. Flowering curves in sprayed and unsprayed plants were identical, though this may in part have been due to the levelling influence of adverse conditions in late December and early January. In previous years, the flowering habits of sprayed and unsprayed plants were apt to differ when treatment gave a measurable degree of protection to the crop.

The effect of early square shedding on the growth habits and cropping capacity of cotton grown on soils with a known high nitrate content, were investigated in a late planted crop. Squares were stripped by hand from one series of plots for two weeks after they first appeared, sprays being applied fortnightly from then on ; in a second series, sprays were applied from the commencement of squaring, first at weekly and later at fortnightly intervals ; in a third series, the sprays were more widely spaced. Significant differences in yield were

not obtained, apparently because the available land did not permit of an adequate experimental lay-out. The data do, however, show a marked tendency to increased yields in the plots sprayed regularly from the commencement of flowering, while the control plots and those from which the first formed squares were removed matured their crop comparatively late. The results lend some support to the view that the destruction of the first formed squares—even when not spectacular —may appreciably affect both the total yields and the structure of the plant.

The main feature of the jassid work has been an attempt to correlate varietal resistance, symptom pictures and insect populations on the plant. In any one variety, positive correlations are apparent between the observed symptoms and the insect population as measured by the number of nymphs on the terminals. Thus the more pronounced the leaf symptoms, the higher the number of insects on the terminal and vice versa. There are indications, however, that a given population will produce more acute symptoms of attack on one variety than on another, but the available data bearing on this point are rather limited. Among the accredited resistant types of cotton, the insect population/ symptom picture relationships are of essentially the same type as those in the more susceptible cottons.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1942-43.

The proposed programme for 1942–43 comprises the following features :—

Plant Breeding.—(*a*) A continuation of the backcrossing work in Miller × U.4 material, which will include studying the progenies of various generations of backcrosses for uniformity of characters, jassid resistance, etc.

(*b*) Testing a comprehensive range of new and old open pollinated material obtained in jassid-infested crops.

(*c*) Yield trials of the most advanced strains of the Miller and Triumph varieties.

(*d*) Multiplication and testing of the most promising of the advanced strains of Miller showing some degree of jassid resistance.

Agronomic and Varietal Experiments.—A continuation of the general programme reported upon for the 1941–42 season with modifications in both the rain-grown and irrigation experiments based on the results obtained in this past season.

Entomology.—(a) Comparisons in irrigated cotton between sprays applied in a regularly spaced schedule from the commencement of squaring and sprays applied by egg-count criteria for the control of corn ear worm.

(*b*) An investigation of the effect of spray schedules on cotton grown in high nitrate soils with particular reference to the effect of retaining the early crop on total yields and the growth habit of the plant.

(*c*) Studies of the population/symptom picture relationships in jassid-infested cotton and their correlation with yields.

SOUTH AFRICA

Introductory Note

by

F. R. PARNELL.

Staff.

Barberton.—The staff remained as in the previous year throughout the growing season, Mr. MacDonald and myself being the only members present. Mr. H. E. King, of the Sudan Department of Agriculture, joined us in June at the request of the Director of Agriculture, Sudan, and has been responsible for the work on quality of lint and correlations of various characters with grades of hairiness, etc.

Swaziland.—The position remained the same as last season, with both officers working under the Administration. Mr. Lochrie continued his experiment station work and Mr. Hutchinson was in charge of native cotton-growing and assisted in the Food Production Scheme.

Commercial Crop.

A considerable increase in the acreage under cotton had been expected, but weather conditions made this quite impossible. The first rains came very late, after a dry period of over seven months, and ploughing could not be started till it was already late for planting cotton. The result was not only a smaller acreage than was intended, but also poorer crops than usual. There was some disappointment in the price realized, 8¼d. per lb., which was considered low in comparison with prices of other farm crops, most of which have risen considerably, and also in comparison with the increased costs of production. For this reason it is not expected that the coming season will show an appreciable increase in acreage over that of 1940–41.

Native Cotton.—It was a most difficult season for native cotton-growing in Swaziland and the fact that some crop was produced is a matter for satisfaction. The possibility of a healthy development appears to lie in the interest shown in the crop by a proportion of intelligent cultivators rather than in any encouragement they receive from above. The price is now good by native standards, but one or two good seasons in succession are required to establish the industry on a firmer footing.

Experiment Stations.

The cotton crop on the Barberton Station was good for so short a season, since conditions were very favourable for early growth. The yield of 5143 in the variety trial, 350 lb. lint per acre, represents the general standard of most of the crop, though some acres of poorer soil gave much lower yields.

Good progress was made with work on hybridization, which is proving of great interest and most promising. The U.4 × Cambodia

material has already given types showing a better combination of desirable characters than has been obtained from pure U.4 strains in the past, and there is every prospect of obtaining stable strains retaining these characters.

The " quality " crosses represent an attempt to combine lint of high quality with good hairiness of plant in a type with the general field characters of U.4. That this is not impossible for physiological reasons is shown by the fact that single plants showing this combination have already been obtained. It is impossible to judge, at present, whether a pure strain with these characters is a genetic possibility. A point of great interest is that both Sea Island and Egyptian cottons carry a gene, or genes, capable of giving very great density of hairs on the whole plant.

Detailed investigation of the degrees and types of hairiness that occur in cotton is urgently required in connection with this hybridization work. The relation between different types of hairiness and jassid resistance, part of the whole problem of resistance to jassid, is also of immediate importance. The preliminary examination of hairiness, started in the present season, will be continued in the coming season as far as opportunity permits.

In Swaziland the work on soil fertility is being steadily developed and evidence is accumulating on the immediate needs of both cotton and maize on different types of soil. It will be some time, however, before the results of different methods of soil treatment, as distinct from manuring, become evident.

COTTON EXPERIMENT STATION, BARBERTON.

PROGRESS REPORT FOR THE SEASON 1941-42

BY

F. R. PARNELL AND D. MACDONALD.

INTRODUCTION.

The proposed programme of work was successfully carried out despite the lateness and shortness of the season, and good progress was made.

In breeding work little time was devoted to pure U.4 material, which was confined to one variety trial of the most important recent derivatives, suitable for local conditions, and some crosses between U.4 strains. The greater part of the time was devoted to crosses between U.4 and other varieties possessing either greater hairiness of plant or better quality of lint.

Jassid was very plentiful in the breeding blocks containing susceptible varieties, but there was no damage elsewhere. Bollworm and stainer damage was negligible throughout.

Crops other than cotton were less well-suited by the season, but were generally fair. The only experimental work with them was a comparison, in variety trials, of streak-resistant strains of maize alongside their parent varieties.

Meteorology.

The total rainfall for the year was 28·25 inches, only slightly less than the mean for the area. The first effective rain fell at the end of November and the last of the season on March 18th, thus the season was both late and short. The previous winter had been exceptionally dry, no effective rain having fallen from April 19th to November 28th, a period of over seven months, and it was impossible to plough and prepare seed beds in advance in the usual manner. Thus the main cotton planting was carried out in early December, a month later than the best time for it.

For about two months after planting, moisture conditions were very good, temperatures were high and the cotton developed much more rapidly than usual, thus partly making up for the late start. A dry period during the first half of February retarded development to some extent, but cotton was less affected than other crops.

Genetics and Breeding.

Variety Trials.—One ordinary trial was carried out, comparing the more recent derivatives of U.4 with 5143, the strain in general cultivation in the area. In addition, two crosses between U.4 strains were included. Stands and growth were good and there was no insect damage, the resulting yields being very good for so short a season. The two crosses were distinctly poorer than the main strains, which ranged from 333 to 387 lb. lint per acre, with 5143 giving 350 lb. per acre. The 5143 derivatives were all about equal to their parent, but three strains from outside this family, two from 921 and one from 920, headed the list with yields significantly greater than 5143 at P=·01.

A small trial was carried out in conjunction with a similar trial at Domira Bay. The same strains were planted in both places, viz. :— Barberton 920 and its derivative 0268, together with Domira Bay 920, as modified there over a number of years, and a derivative raised there.

Unfortunately the 0268 seed was poor and the resulting bad stand necessitated the omission of this strain from yield comparisons. Growth was good, but the crop suffered rather severely from premature leaf-fall, which reduced yields and is likely to have lowered the quality of the lint. Of the Domira Bay strains, 920 yielded 875 lb. per acre of seed-cotton, and its derivative 855 lb., both being significantly lower than Barberton 920, which gave 951 lb. per acre.

Lint samples of the above strains have been sent from both Stations for spinning tests, in order to determine whether the differences in spinning value commonly shown between strains from the two areas are due to genetic differences or to environment.

Hybridization.—Almost the whole of the breeding work now carried out at the Station is concerned with hybrid material. The objects of the work have been given in detail in last year's Report and in the Programme for 1941–42. Briefly, the main object is to combine in one general type the many good characters of U.4 with greater hairiness and better quality of lint.

Crosses within U.4.—Details of these crosses were given in last year's Report, p. 22. The material carried on this season included bulks and single plants, which were grown alongside their parents in replicated plots. Analysis of this material gave disappointing results and there was no indication of success in the attempt to combine the higher ginning percentage and longer lint of 8161 with the stronger 5143 plant. Two bulks put into the variety trial gave the lowest yields there, significantly lower than 5143 and the majority of the other strains. In view of these results the material has been discarded.

U.4 × Cambodia.—These crosses were again most encouraging and fully bore out their promise of the previous season. They comprised 180 single-plant selections made up as follows :—100 from (5143 × Cambodia) × 5143, 50 from the F_2 and 30 from the similar backcross and F_2 with 5149 as parent. Planted in 6- to 8-row progeny plots, with their parents at intervals, they covered 10 acres.

Observations during this season confirmed those of the previous two seasons, that the 5149 crosses were inferior to the 5143 lots in all characters : they have now been discarded entirely.

The 5143 lots provided a great deal of very good material for selection and both bulks and single plants taken from them combined good field characters, a high degree of hairiness and lint rather longer than U.4. Classification into different grades for hairiness was done by eye as in the previous season.* A high and very significant correlation, $r = +\cdot5076$ in the backcross and $r = +\cdot4975$ in the F_2 lots, was found between hair grades of parents and their progenies, showing that this method of grading is of practical value. Lint length values for parents and progenies also showed a high correlation, $r = +\cdot5415$. As in the previous season, there was a small but significant negative correlation between lint length and ginning percentage.

The mean figures for selected plants carried forward are given in Table I, which also includes similar selections from the M.U.8 × U.4 lots described in the following section. It may be noted that all material analysed this season has shown a marked decrease in ginning percentage as compared with normal seasons. The decrease in the case of the Cambodia crosses could be largely explained by their high seed weights, but this is not the case with other material. The lower

* 1+ represents the greatest and 6 the least degree of hairiness.

ginning percentage was common to the area generally, and the local ginnery returns for the whole crop gave 32·4% against 35·7% for the previous season.

TABLE I.

SELECTIONS FROM U.4 CROSSES.

Cross	*No. Plants*	*Yield per Plant, gms.*	*Ginning %*	*Weight 100 Seeds, gms.*	*Lint Length, mm.*	*Range of Hair Grades*
(C.×5143)×5143 ...	89	201	34·7	11·2	33·7	3+ to 1
Do. F_2 ...	54	171	35·1	11·3	33·4	3+ to 1
M.U.8×8161, F_2 ...	55	161	33·8	9·4	30·1	2 to 1+
M.U.8×8171, F_2 ...	45	172	33·1	8·8	29·6	2 to 1+
M.U.8×8202, F_2 ...	46	†276	33·6	9·3	30·2	2 to 1+
Standard 5143 ...	Bulk	—	34·0	9·1	32·0	3

†N.B.—*The yields in this group were helped by a patch of land on which Alternaria did not develop.*

These are excellent records for the Cambodia crosses for the second season running, and they show a most satisfactory combination of good lint length with a high degree of hairiness. About 95% of them were given hair grades better than 3+, the grade of the hairier Cambodia parent. Again the yields, which were very good for so short a season, were due more to good fruiting than to size of plant, though growth was very satisfactory. A total of 143 single plants and 66 small bulks have been carried forward in this material.

U.4×M.U.8.—This is another cross made with a view to improving U.4 hairiness. M.U.8, a Malwa Upland type, is the hairiest *hirsutum* parent we have and grades 1+ to 0. It is a compact, free-fruiting type of plant, but its ginning percentage is rather low and the lint shorter and harsher than that of U.4.

Three U.4 strains were used as parents, 8161, 8171 and 8202, and the F_2's and backcrosses to the U.4 parents occupied 2 acres. Large special bulks were taken from the backcrosses, to give material with greater variation for selection in the coming season, and single-plant selections from the F_2 lots. The material generally was good, and the selected plants combined excellent field characters with very good hairiness, 60%—80% being better than grade 2. Mean figures for the three lots of selected plants are given in Table I. It will be seen that the ginning percentages are nearly up to that of 5143, but the lint lengths are definitely low. There was a good deal of variation in the latter character, however, and it is hoped that further selection will lead to an improvement. The immediate usefulness of the material will depend on the extent to which this is possible.

In the 8161×M.U.8, F_2, all plants in a few lines were graded for hairiness, with the following results :—

Grades	1+	1	2+	2	3+	3	4	5	6	*Total*
Total Nos.	4	12	54	100	34	23	3	3	1	234
Nos. taken for correlations	4	12	26	25	25	20	3	3	1	119

A few of the hairiest plants reached 1+, the lower range of M.U.8, and a small number were less hairy than 3, the grade of 8161. The variation was continuous, with no indication of definite groups to throw light on genetic constitutions.

The lower line of the above table shows the distribution of 119 plants, covering the whole range of hairiness, taken to examine possible correlations between hairiness and other characters. Degree of hairiness has been found to be positively correlated with yield and negatively with lint length and " feel in bulk " (degree of fineness and silkiness). The figures obtained were—*Yield*, $r = +\cdot3226$; *" Feel in Bulk,"* $r = -\cdot3362$; both significant at P = ·001.; *Lint Length*, $r = -\cdot2852$, significant at P = ·01. No significant correlation was found between lint length and yield or " feel in bulk."

One of the difficulties in breeding for hairiness of plant is that this character tends to be associated with short harsh lint. It has been easy to find individual plants combining the required characters of good hairiness and long, fine lint, but it remains to be seen whether stable strains can be obtained with this combination.

Quality Crosses.

U.4, 8161 × Sea Island, V.135.—About ½ acre each was planted of F_2 and the backcross to 8161. The backcross, which gave a smaller range of types, was used mainly as the source of a special bulk to provide material giving greater variation for selection in the coming season. A few single-plant selections were also taken from it.

In F_2 the very wide range of types could not be analysed in detail, but particular attention in the field was paid to hairiness and jassid damage, which both varied enormously. A straightforward grading for hairiness, as with the *hirsutum* material, was possible for only a small proportion of the plants. Of these a few, about ·35% of the F_2, showed greater hairiness than the U.4 parent. Certain new types of hairiness appeared, the commonest being one in which the leaf, or leaf and petiole, carried markedly greater hairiness than the stem. In addition, there were plants, about ·5%, showing very high hair densities on stem, petiole and leaf. A plant of this type is included in the hair measurement data of Table II below. There was also much variation in hair length.

Jassid infestation became severe before the detailed examination for hairs could be made, and this interfered with our notes on the more glabrous types, since these were all seriously damaged. Plants classified for jassid damage as " rather bad " or worse, totalled about two-thirds of the whole population, and included about 10% with very bad damage, the plant being almost killed, as with the Sea Island parent. Less than 10% showed damage " slight " or less.

There was a very close connection between hairiness and jassid resistance, but the fact that the hairiness varied in type as well as in degree made it difficult to tabulate one character against the other.

In general terms it may be stated that hair on the leaf lamina appeared to confer resistance to jassid, irrespective of the condition of the stem or petiole, and that the greater the leaf hairiness, the greater was the resistance. Some plants with a stem as glabrous as Sea Island, but with good hairs on the leaf, showed high resistance.

An additional complication in the study of this connection was the wide range in earliness of fruiting in the material. All our experience indicates that, other things being equal, the more fruit a plant is carrying and the more advanced the fruiting, the more susceptible it is to jassid damage. It will be possible to avoid this complication to a greater extent with later generations of the material.

An attempt was made to relate hairiness of the plant to length and quality of lint, but the material was not really suitable for this purpose. The lowest degrees of hairiness, about two-thirds of the population, had to be ruled out as the plants were so badly damaged by jassid as to give no lint fit for examination. Amongst the better plants there was no regular correlation between hairiness and either lint length or fineness and silkiness, as judged by " feel in bulk," though there was a slight indication that the longer and finer types were commoner in the plants with less hairy *stems*.

Many good plants were selected, showing a combination of good hairiness and jassid-resistance with long, fine lint, some of them also giving very satisfactory yields. Plants with hair grades of 3+ or better gave a mean lint length of 36 mm. Other plants are being carried forward to throw light on the new types of hairiness and their relation to jassid-resistance and quality of lint. In all, 114 single plants were carried forward.

U.4, 8161 × Egyptian, X1530.—The F_2 and backcross to 8161 occupied about $\frac{1}{4}$ acre each.

Hairiness behaved in the same manner as in the Sea Island crosses above, the same new types appearing, but the general level of hairiness was somewhat higher, since a smaller proportion of the plants were essentially glabrous. The relation between hairiness and jassid damage was very marked in the same way.

Working with 55 plants showing jassid damage of " nil " to " moderate," a definite correlation was found between degree of hairiness of the *stem* and lint length, the more hairy types having shorter lint, $r = -\cdot 4184$, significant at $P = \cdot 01$. No relation between hairiness and " feel in bulk " could be detected, but variation in jassid damage and also in earliness of fruiting was a more disturbing factor here.

As in the Sea Island lots, many plants were found giving the required combination of hairiness and lint quality well above the U.4 standard. Plants with hair grades of 3+ or better gave a mean lint length of 34·4 mm. Altogether 56 single plants, mainly from F_2, and a special bulk from the backcross, have been carried forward.

Miscellaneous.—Many other crosses, with the same general objects in view, have been made or carried a step forward during the season. The hairy parents used regularly have been U.4 (5143) and M.U.8, but some use has also been made of three Upland varieties recently received from Trinidad, Batangas, Ferguson and Kapas Purao. These are all very hairy and leafy types, with hairs slightly longer but of rather lower density than those of M.U.8.

Of " quality " parents, Coker Wild's is one of the most important and we shall have large F_2's of this crossed with U.4 and M.U.8 in the coming season, also backcrosses to both parents in each case. An extremely promising parent is B.P.52 from Uganda, since the lint is of high quality and the hairiness is far greater than any other parent with lint of the same class. There is some indication of a negative correlation between degree of hairiness and quality in this strain, a point that will be examined more closely in the coming season. Meade and Tidewater also appear to be promising, and further use is also being made of Sea Island and Egyptian, X1730 being substituted for X1530 in the latter case.

A serious difficulty in judging the lint of these " quality " parents, as grown here, is that they are essentially non-hairy types, with the exception of B.P.52, and suffer so much from jassid damage that their lint is affected.

Hairiness of Plant.—Reference was made in the report for last season, p. 23, to the classification of plants by eye into various grades for degree of hairiness. This method has been continued in the present season and has proved useful with similar material. It is most desirable, however, to make a microscopical examination of such grades in order to determine the actual nature of the hairiness, *e.g.*, the density and lengths of the hairs, that they represent.

In our ordinary *G. hirsutum* material, the degrees of hairiness of stem, petiole and leaf lamina (under side) appear to be closely associated and the three are taken together in grading a plant. The petiole was selected as the most easy part to deal with in a preliminary attempt at a detailed examination. (This does not imply a belief that the hairiness of this part is of paramount importance from the point of view of jassid-resistance.)

The stage of growth was standardized by taking the first fully-grown leaf of normal colour, below the growing point, of a plant in full flower. About 5 mm. of the petiole was taken off in thick cross sections, starting 1 cm. from the lamina. The sections were mounted in water under the microscope ; all hairs were counted and the undamaged ones were measured with an eyepiece micrometer. The surface area of the length of petiole cut was easily calculated and from this the density of hairs was obtained. A preliminary examination of a wide range of material was made in this manner, in addition to representatives of the grades referred to above. Some of the results are given below, since

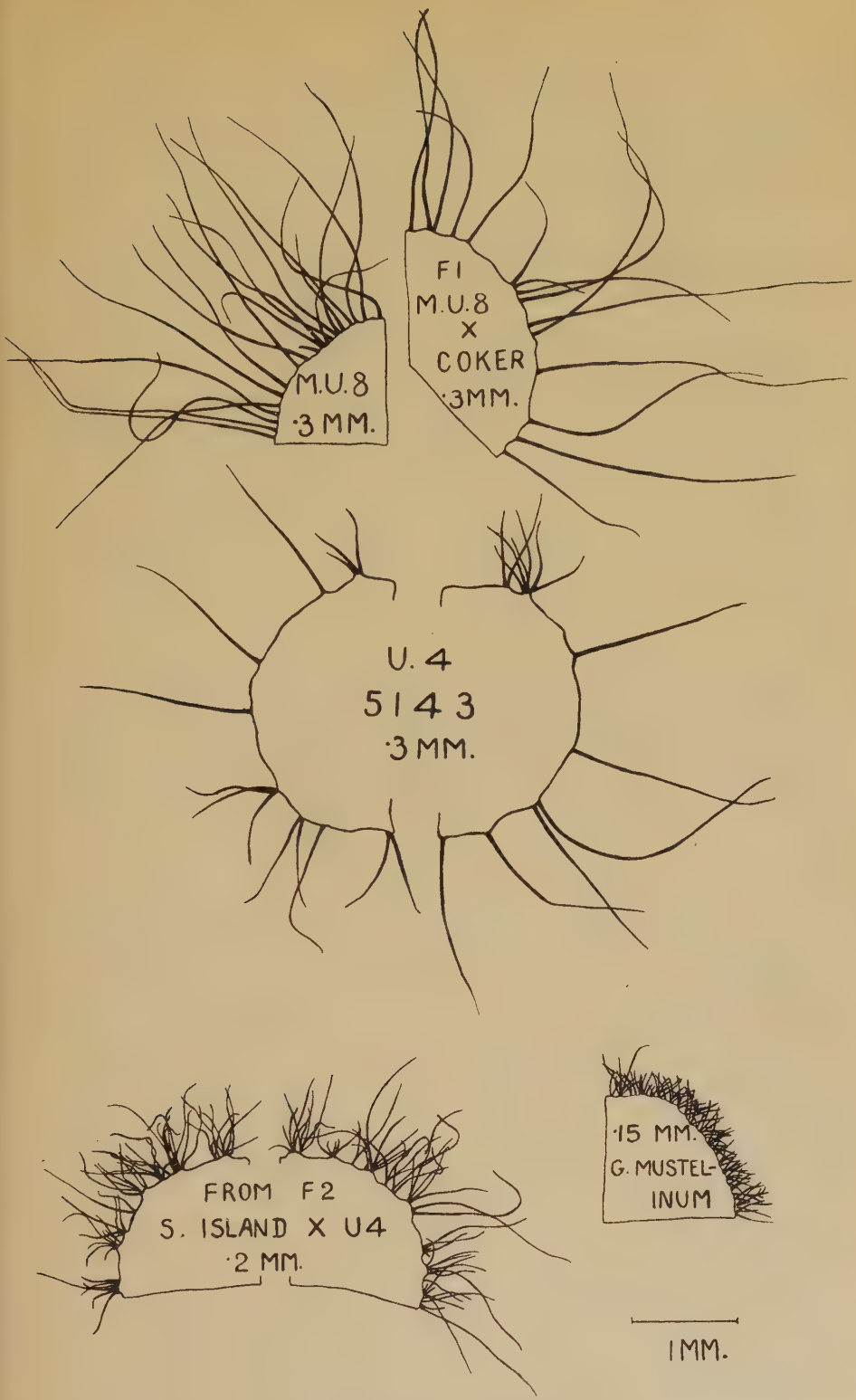

FIG. 1. PARTS OF PETIOLE CROSS-SECTIONS SHOWING HAIRS. THICKNESSES OF SECTIONS ARE NOTED.

they are of considerable interest, though the samples employed were not large enough to give strictly accurate figures for final recording against the various types.

Fig. 1 shows camera lucida drawings of parts of petiole cross sections of various types of cotton. They are all to the same scale, but the sections vary in thickness, as shown on the drawings.

In all cases single and compound hairs (bunches) occurred mixed, but there was much variation in their proportions and in the numbers of individual hairs in a bunch. In all counts and measurements the hairs in a bunch were recorded separately as with single hairs. In general, for any one type, the single hairs are the longest and the greater the number in a bunch, the shorter they become. The wide range of variation found will be seen from the following figures of percentages of hairs occurring singly and in bunches with various numbers of components.

	Singles	*2 or 3*	*4 or 5*	*Above 5*
M.U.8	77·6	22·4	—	—
U.4, 5143	30·5	43·0	21·0	5·5
G. mustelinum	—	14·3	82·2	3·5

The figures given in Table II show the enormous variation, in both density and length of hairs, on the range of material examined. The grades for hairiness, effects of jassid on the plant and lint lengths, are as recorded for the plot as a whole, except for the single F_2 plant included.

TABLE II.

HAIRINESS OF PETIOLE AND OTHER CHARACTERS.

Variety	*No. Plants*	*Hairs*			*Hair Grade*	*Jassid Effect*	*Lint Length mm.*
		Density Sq. mm.	*Length mm.*	*D×L*			
Sea Island, V.135	6	·23	·40	·09	—	V.V. Bad	42·3
Egyptian, X1730	6	·66	·46	·30	—	V. Bad	35·7
Coker Wild's	6	·51	·87	·44	6	Do.	35·2
Tidewater	6	·63	·71	·45	6	Do.	36·9
Coker × 5143, F_1	6	4·3	·79	3·4	4	Moderate	32·9
U.4, 5143	8	11·4	1·01	11·5	3	Slight	31·2
M.U.8	4	37·1	1·75	64·9	1+ to 0	Nil	25·9
Coker × M.U.8, F_1	6	11·2	1·66	18·6	3+ to 2	V. Slight	30·9
G. mustelinum	1	244	·27 (Straight)	65·9	—	Slight	—
G. tomentosum × U.4, 5149, F_1	2	329	·27 (Curled)	88·8	—	Moderate	23·8
Sea Island × U.4, 8161 (an F_2 plant)	1	114	·70	79·8	—	Slight	37·6
U.4, 6135, poor growth, no manure	10	10·3	·92	9·5	3 (bare)	Slight (more)	
Do. good growth, heavily manured...	10	12·1	1·21	14·6	3 (good)	Slight (less)	
Sig. Diff. for P=·01... ... (*Last two lines only*)		*N.S.*	*·20*	*5·0*			

Sea Island is the least hairy, followed closely by Egyptian. In both cases the stem is more nearly glabrous and the underside of the leaf less so than the petiole. Coker Wild's and Tidewater, two long-stapled Uplands with fine lint, differ from Egyptian mainly in the greater length of hair ; also there is not the difference shown by the latter between stem, petiole and leaf. The U.4 type, 5143, shows a very great increase of density with a slightly greater length and its cross with Coker gives an intermediate density with a length probably in the same class as the two parents. In M.U.8, the hairiest Upland type we have seen, the density is much higher still and the length is also markedly greater. Again the cross with Coker gives an intermediate density, whereas the length nearly approaches that of the M.U.8 parent.

G. mustelinum and *G. tomentosum* × U.4 introduce an entirely different type of hairiness, both giving extremely high density and very short hairs, so much so that it is difficult to see with the naked eye that the surface is hairy. They differ in that the hairs of the former are straight, whereas in the latter they are curled and matted together. The F_2 plant from Sea Island × U.4 is of particular interest, since it combines a very high density, ten times that of the hairy U.4 parent, with a length not very greatly less. To the naked eye this hairiness appears, at first sight, to approach that of *mustelinum*, since the density masks the greater length.

General observations in the field have frequently indicated that vigorous growth has tended to a better development of hairs. The two samples of U.4, 6135, at the end of the table, confirm these observations, both *length* and *length* × *density* being significantly higher for the better grown plants.

From the notes recording the degree of damage by jassid, it will be seen that all the four types which lack appreciable hairiness were very badly affected. Sea Island was almost killed and gave no fully normal bolls ; Egyptian and Tidewater were little better, giving no real crop, but Coker did give some crop. It should be noted that all four were making good healthy development before the jassid infestation became heavy. For the next four lots, as the hairiness increased the jassid damage decreased, M.U.8 showing no effect whatever. Our Grade 3, represented by 5143, typical of the ordinary U.4 strains, is just good enough to escape real damage to the crop in our conditions, though the plant may show some effect. In the U.4 × Coker, Grade 4, the yield was undoubtedly affected to some extent. The jassid population in the vicinity of all these varieties was much higher than usual, owing to the large amount of highly susceptible material in the block.

The three types with very high density appear to fall into another category. The infestation by jassid nymphs and resulting damage to the plant were both definitely higher in the *G. tomentosum* cross than in *G. mustelinum*. The former, with its much-curled and matted hairs, presents a surface over which both adults and nymphs of all

sizes appear to move with the greatest freedom. Whether such lack of obstruction influenced the ovipositing female is a matter for future study. A difference between these two species that may have been a contributing factor is that *G. mustelinum* was much later in coming into flower.

The lint lengths are included in the table as a matter of interest. It is most noticeable that the longer-linted types are less hairy, a common experience with commercial varieties, but less evident in our hybrid material. The F_2 plant from Sea Island × U.4 is an example of great hairiness combined with long lint. There were others of this type in the same family and also in the corresponding Egyptian × U.4, F_2.

Reference has been made in the section dealing with the above two crosses to the occurrence of plants with essentially glabrous stems, but with hairy leaf or petiole and leaf. It is obvious that examination of the petiole alone is of no value in such types. A great deal of detailed work is required to throw light on the whole problem of hairiness, and also on the nature of the connection between hairiness and jassid-resistance. The two subjects should be studied together if possible. Further work will be continued here as time permits.

Experiments.

Premature Leaf-fall.—Reference has been made to this subject in many previous reports and the main facts were recapitulated in the 1940–41 Report, p. 25. The results given there appeared to indicate that the "debility" which encourages *Alternaria* and consequent leaf-fall is not due to nitrogen-starvation. A further manurial experiment bearing on the same subject has now been carried out on red loam soil.

The following 12 treatments were given, in a randomized block lay-out with 10 repetitions :—

KLC, KC, LC, C ; KLN, KN, LN, N ; KL, K, L, Nil.

K = 500 lb. per acre, K_2SO_4.
L = 9 tons per acre ground limestone.
C = 12 tons per acre compost, from kraaled wastes (equal to approx. 120 lb. N and 75 lb. K_2O).
N = 500 lb. per acre $NaNO_3$ in 3 topdressings :—
(1) 100 lb. at 20 days from planting.
(2) 200 „ 40 „ „
(3) 200 „ 78 „ „

All treatments received, in addition, 500 lb. per acre of superphosphate.

Growth.—Green weights at 32 days, and height measurements at 42 days, gave very similar results for treatment effects on early growth. All treatments receiving compost were outstanding and gave very highly significant increases over all corresponding treatments without compost. KL, L and K were all significantly greater than Nil, in that

order, but with no significant differences between them. It was too early for N to have become fully effective and the slight increases shown were not significant.

General observations later in the season, before leaf-fall had started, again showed all C plots to be outstanding, with KLC slightly better than the others. In the absence of compost, L gave an appreciable increase in growth, K a very slight one. In some cases N seemed to have given very slightly better growth, but this was not regular enough to be recorded with certainty.

Yield.—The yields of seed-cotton showed many very large and highly significant treatment effects. Table III gives the yields of all treatments, arranged to show the effects of nitrate and compost in all combinations of K and L. It will be seen that nitrate gave significant increases only in the absence of lime, whereas the increase with compost was very highly significant in all cases. All C treatments were also very significantly higher than the corresponding N treatments.

TABLE III.

YIELDS OF ALL TREATMENTS IN LB. PER ACRE, SEED-COTTON.

Nitrogen Supply	*No Lime*		*With Lime*		*Mean*
	—	*K*	*L*	*KL*	
Nil	521	872	678	1,111	796
Nitrate	744	1,019	682	1,204	—
Increase over Nil	*223*	*147*	*4*	*93*	—
Compost	1,160	1,216	1,205	1,388	1,242
Increase over Nil	*639*	*344*	*527*	*277*	*446*
Sig. Diff., P=·05	*124*				*62*

Other effects are better seen from tables arranged to show certain interactions. Table IV shows the effect of lime and its interaction with nitrogenous manures. Lime has given a large and highly significant increase in the absence of nitrogen, a smaller but still significant increase with compost and a still smaller and not significant increase with nitrate. These differences in response, though highly suggestive, are not statistically significant at P =·05 when worked out in the ordinary manner.

TABLE IV.

LIME AND NITROGEN; MEANS FOR WITH AND WITHOUT POTASH.

Lime Supply	*No Nitrogen*		*Nitrate*		*Compost*	
	Lb. per acre	*% of No Lime*	*Lb. per acre*	*% of No Lime*	*Lb. per acre*	*% of No Lime*
No Lime	696	100	882	100	1,188	100
Lime	895	128	943	107	1,297	109
Increase	*199*	*28*	*61*	*7*	*109*	*9*
Sig. Diff., P=·05	*87*	*12·6*	*87*	*9·9*	*87*	*7·4*

Table V shows the effect of potash and its interaction with nitrogenous manures. In all cases potash gave a significant increase, but this was very much smaller in the presence of compost. This difference in response is very highly significant. Such interaction would be expected, since the compost dressing contained an appreciable amount of potash, though obviously not enough to supply the full requirements.

TABLE V.

POTASH AND NITROGEN; MEANS FOR WITH AND WITHOUT LIME.

Potash Supply	*No Nitrogen*		*Nitrate*		*Compost*	
	Lb. per acre	*% of No Potash*	*Lb. per acre*	*% of No Potash*	*Lb. per acre*	*% of No Potash*
No Potash	600	100	713	100	1,183	100
Potash	992	165	1,112	156	1,302	110
Increase	*392*	*65*	*399*	*56*	*119*	*10*
Sig. Diff., P=·05	*87*	*14·6*	*87*	*12·2*	*87*	*7·4*

Table VI, giving the effect of potash with and without lime, shows a very highly significant increase in both cases. The response is much greater in the presence of lime, however, and the difference in response is very highly significant.

TABLE VI.

POTASH AND LIME; MEANS FOR THREE NITROGEN TREATMENTS.

Potash Supply	*No Lime*		*With Lime*	
	Lb. per acre	*% of No Potash*	*Lb. per acre*	*% of No Potash*
No Potash	808	100	855	100
Potash	1,036	128	1,234	144
Increase	*228*	*28*	*379*	*44*
Sig. Diff., P=·05	*71*	*8·8*	*71*	*8·3*

Alternaria.—As regards "closing down," the whole area went off very badly in the end, the leaf being attacked by *Alternaria* and shedding rapidly. All plots receiving either C or K remained green longer, however, the onset of *Alternaria* being retarded by about 3 weeks, with no visible differences between the C, K and CK treatments. There was no indication that N or L produced any effect on leaf-fall. Patchiness of the land caused some unevenness in growth and correspondingly marked differences in time of closing down. Plots without C or K started to go off when just over 3 months' old where growth was poor, and at about 4 months for good growth.

We have previously found that better growth, whether due to manurial treatments, poor stand, border effect, patchiness of land, etc., has delayed the onset of *Alternaria*. Here, also, compost has improved

growth and delayed leaf-fall ; but potash has produced an equal delay with very slight increase in growth, and lime has increased growth appreciably without affecting leaf-fall.

If the delay is a specific effect of potash, it is possible that the effect of compost may be due to its potash content. This represents only a small application, however, not sufficient for the needs of the plant (the KC treatment significantly outyielded C), but the delay in leaf-fall was no more pronounced for KC than for C.

It is noteworthy that in no treatment was the attack of *Alternaria* prevented. All composted plots were good, particularly those receiving KLC. The latter gave excellent growth and general plant development, looked perfectly healthy before leaf-fall started, and gave very good yields : yet they also were severely attacked by *Alternaria*, their leaf being shed rapidly before the crop was mature, and some loss of late crop resulted. It is difficult to imagine that these plots suffered from potash starvation, or from any lack of P or N, and there was no lack of moisture when they started to go off.

It is possible for a plant to be overburdened with developing fruit and to be so far drained of one or more important constituents as to become debilitated. Similar heavily fruiting crops on other types of soil in the district normally " finish " healthily, however. There appears, therefore, to be some responsible factor associated particularly with our red loam. This could be a deficiency of some minor element that is drawn on heavily during boll development. On the other hand it might be connected with the type of root development produced and the rate of uptake of soil water and nutrients. We know definitely that this soil gives a steadier growth than the lighter soils of the area, and does not show the rapid spurts of growth seen on the lighter soils in particularly good conditions.

Spinning Test Samples.

Extensive analyses of the results of spinning tests on the material referred to in the 1939–40 Report, p. 24, have now been carried out. Many features of interest have emerged throwing light on the accuracy of lint sample comparisons and indicating the precautions necessary in sampling and in interpreting the results. A note is now being prepared on this subject and some only of the more outstanding points are referred to briefly below.

The accuracy of the spinning test as carried out at the Shirley Institute is high ; duplicate spinnings of portions of the same sample give results in close agreement. The particular set of samples submitted was suited to spinning at counts of 30's to 40's, but it appeared that the *count* × *strength* product (lea test) obtained by spinning at 50's was more sensitive to differences between samples than the figure obtained at lower counts.

In order to simulate sets of samples from randomized block variety trials, series of composite samples were prepared by combining lint

from separate small plots of the same strain. For one series the field providing the samples was divided into twelve blocks and each block into twelve single-row plots, 162 ft. in length. Twelve composite samples were then made up, each contributed to by one plot from each block. This series gave a variation in count × strength product which, although satisfactorily small (Coeff. of Variation 1·79% at 40's and 2·94% at 50's), was significantly greater at 50's than that given by duplicate spinnings of the same sample (Coeff. of Variation 1·67% at 40's and 1·69% at 50's).

A second series made up in the same way, but including cotton from seven replicates only, gave distinctly more variation (Coeff. of Variation 2·29% at 40's and 4·31% at 50's).

With both these series the variation from sample to sample in yarn strength at 40's was as great as that shown by the mean yields of the groups of replicates contributing to the composite sample. It appears from this that adequate replication is just as essential for accurate comparisons of quality as it is for yield comparisons—a point of importance which has not received universal recognition in the past.

Results from a series of samples consisting of five distinct strains, each grown on replicated plots in six different fields, indicated that spinning quality may vary very much more between fields than between strains, even when the fields give comparable growth and yields of the same order. Taking the mean of the two count × strength products from spinnings at 40's and 50's, the variance ratio for *strains* compared with residual error was 4·33, while that for *fields* was 7·54. In this experiment the five strains differed markedly amongst themselves in certain of the fields, while in other fields strain differences were of negligible magnitude. Moreover, considering only those fields in which strain differences were marked, the order of merit of the strains for yarn strength showed poor agreement from field to field, and in certain cases was entirely contradictory.

It would appear, therefore, that in evaluating strains for relative lint quality, it is essential not only to ensure that the samples for comparison are taken from comparable replicated plots, but also to extend the comparison to include a series of samples representing as far as possible the range of conditions within the cotton-growing area to which the results are to be applied. Comparison of a single pair of samples may in many instances be utterly misleading, subsequent experience entirely reversing the results obtained.

One further point of considerable interest is the existence in the " Five Strains by Six Fields " experiment of a negative correlation between yield and yarn strength. Eliminating the effect of strain differences by utilizing the " within strains " component of the analysis of covariance, a value of −·6412 was found for the coefficient of correlation between yield of lint and count × strength product (mean of the values for spinnings at 40's and 50's). This coefficient considerably exceeds the magnitude required for significance at

P =·01, and it seems clear that, in this experiment, the factors responsible for variations in yield have produced variations in spinning quality of the opposite sign. A discussion of this result and of the relationship of both yield and yarn strength with the measured hair characters will be included in the note referred to above.

Rotation Crops.

The season was not very good for rotation crops, as a dry spell from mid-January to mid-February reduced the yield of both maize and leguminous crops. Late-planted maize was affected by army worm attack and also by heavy streak infection.

Experimental work was confined to variety trials of maize, at two planting dates, in which streak-resistant strains bred here were compared with their parent varieties. The yields from these trials are given below, in lb. per acre of grain.

Strain	*Medium, Dec. 9th*	*Late, Jan. 9th*
Hickory	2,387	1,463
,, Streak-resistant	2,119	1,916
Peruvian	1,739	1,722
,, Streak-resistant	1,363	971
Sig. Diff., P=·01	*141*	*154*

Both resistant strains give a less robust style of plant than their parent varieties, the result being that, in the earlier-planted trial, where there was no streak, both varieties have significantly outyielded their resistant strains. In the late trial Hickory was heavily infected and gave a markedly lower yield than the resistant strain derived from it. The ordinary Peruvian bulk, which itself possesses considerable resistance, was little affected by streak in the later planting, and considerably outyielded the resistant strain. The latter, though it is very highly resistant, does not offer much promise of being practically useful.

In the late trial counts of plants infected with streak to different degrees were made at the peak of infection on March 10th. These are given as percentages in the figures below.

Strain	*Light*	*Medium*	*Heavy*	*Total*
Hickory	17·5	17·3	20·3	55·1
,, Streak-resistant	5·7	2·9	2·1	10·7
Peruvian	3·7	1·9	1·7	7·3
,, Streak-resistant	0·3	—	—	0·3

Seed of the resistant Hickory strain has been issued to local farmers for trial for late planting where streak is prevalent and also, at the request of the Department of Agriculture, to some of their Experiment Stations for trial in other streak areas.

The second half of the old rotation experiment was planted uniformly with maize, but damage by army worm made it impossible to obtain figures for yield from the different rotation treatments.

Part of the Station was planted with pigeon pea, which again proved effective in suppressing weeds and provided a big bulk of material for cattle food and compost making.

Summary.

1. The season was late and short, but conditions were otherwise good and the full programme of work was carried out.

2. In a variety trial of U.4 strains, 5143, now in general cultivation, was about equal to its derivatives, but was outyielded by three strains of other families.

3. A small trial was planted with Barberton 920 and a derivative, alongside 920 as modified after some years at Domira Bay and a derivative raised there. Barberton 920 gave a higher yield than the last two. Lint samples from this trial, and also from a similar trial planted at Domira Bay, have been sent for spinning tests.

4. The following hybrid material was carried a step further :—

(*a*) Crosses inside U.4 offered no promise and were discarded.

(*b*) U.4 × Cambodia lots were again very good and have been carried forward as bulks and single-plant selections.

(*c*) U.4 × M.U.8, F_2 lots, gave excellent plants in the field, but with rather low lint lengths. Further selection may improve this character. In this material degree of hairiness of the plant was correlated positively with yield and negatively with lint length and " feel in bulk " (fineness and silkiness).

(*d*) U.4 × Sea Island and Egyptian, F_2's. New types of hairiness appeared here, including almost glabrous stem with very hairy leaf and a type with extremely dense hairs throughout. Hairiness of leaf lamina appeared to determine jassid resistance. The occurrence of plants combining long, high quality lint, great hairiness and very good field characters, makes this material appear promising.

(*e*) Both U.4 and M.U.8 have been crossed with several *hirsutum* parents carrying high quality lint.

5. Preliminary work on measurements of " hairiness " showed the immense range and complexity of this character and illustrated the connection normally found here between hairiness and jassid-resistance.

6. A manurial experiment in connection with premature leaf-fall associated with *Alternaria*, showed that both potash and compost delayed the onset of the disease, but did not prevent it.

7. In two maize variety trials, medium- and late-planted, streak-resistant strains of Hickory and Peruvian were compared with their parent bulks. In the earlier trial both strains gave lower yields than their parents, but streak infection was severe in the late trial and the resistant Hickory strain considerably outyielded its parent.

PROGRAMME OF WORK FOR 1942-43.

Cotton Breeding.

Variety Trials.—These will be the same as in the past season, viz. : an ordinary trial of U.4 strains and the small trial of 920 strains, in conjunction with a similar trial at Domira Bay, mainly for spinning tests.

Hybridization.—This work will be continued on the lines described in the present Report.

The preliminary study of " hairiness " will be continued as far as time permits, and an attempt will be made to adapt the method employed in the past season to hairs on the leaf lamina. Particular attention will be paid to the relation of various types and degrees of hairiness to jassid damage on the one hand and to lint characters on the other. The latter connection will be examined carefully in B.P. 52.

Rotation Crops.

Maize.—Variety trials to compare the streak-resistant strains of Hickory and Peruvian with their parent varieties will be continued and a resistant strain from the inter-variety cross will be included.

SWAZILAND

COTTON EXPERIMENT STATIONS, BREMERSDORP AND CROYDON.

PROGRESS REPORT FOR THE SEASON 1941-42

BY

J. V. LOCHRIE.

Introduction.

The experimental work of the Stations has been carried on as in the previous season, while Mr. Hutchinson has again been engaged in the promotion and supervision of native cotton-growing and in assisting the Government food production scheme.

The main work of the Stations was on soil fertility problems, while strain tests of cotton and of maize and kaffir corn were continued.

In general, the season was one of low and ill-distributed rainfall, and yields of all crops were low. Cotton in the low veld areas again showed its suitability to conditions too dry for maize and some excellent crops were recorded. The higher prices obtaining for cotton had attracted more growers and a substantial increase in acreage was foreshadowed, but the winter was too dry for ploughing and effective rains did not fall in most areas until December. As a result of the late arrival of planting rains the native was preoccupied with his food crops, while the proposed European cotton acreage also showed a substantial drop. Apart from the climatic conditions the main factor in reducing yields was the heavy attack of red bollworm.

In past reports the work of the two Stations has been treated together, but this season, for the sake of clarity, it has been decided to deal with the work of the two Stations in separate sections.

BREMERSDORP STATION.

This Station is in an area of good rainfall, averaging 35 inches per annum, and is at an altitude of 2,100 feet. The soil varies from a red, medium loam to a light, sandy type. Except where otherwise stated the experiments were planted on the loam.

Meteorology.

The rainfall was high—nearly 40 inches from July to June—but the distribution was not favourable ; nearly one-third of the total fell in May and June, too late to benefit any of the season's crops.

Ploughing had been completed early and cotton and most of the maize was planted after a good fall in early November. Three weeks of dry weather with exceptionally hot winds followed and this was accompanied by a plague of grasshoppers which defoliated cotton.

As a result of the dry conditions and the grasshopper damage some cotton and maize experiments had to be re-planted. The position until March was precarious, particularly for maize as the main tasselling occurred in dry periods. The maize crop, though never showing obvious drought damage, did not have enough moisture at critical periods and yields were below average.

The cotton crop had a bad start, early growth being poor as a result of the hot, dry winds and grasshopper damage. Later growth was affected by the poor start and by an attack of aphis in February, and the final yields were the lowest yet recorded on the Station. The crop failure was partially due to restricted growth, but the major factors were the severe red bollworm infestation and the prevalence of bacterial bollrot in the cloudy and wet March period. A late flush of flowers promised well, but no effective rain fell for 7 weeks after March 16th and the late crop did not mature.

AGRICULTURE.

Fertilizer and Rotation Experiment.—This experiment, which is now in its fourth year, was planted to cotton. The rotation is maize and cotton alternating, except for the Nil (B) series which is planted to maize each year.

The treatments are applied in alternate years—*i.e.*, to maize only—with the exception of KMP (B) which is applied annually.

Treatment.	*Rate per acre.*	*Yield per acre lb. lint.*	*Green Wt. (61 days).*
Nil (A)	... ...	69·5	65·2
Nil (B)	... ...	—	—
P.	200 lb. Supers.	111·6	117·3
KM.	4 tons Compost	113·8	123·1
KMP (A)	KM plus P.	136·2	147·2
KMP (B)	KM plus P.	179·8	193·3
Significant difference required	P.=·01	34·7	41·5
„ „ „	P.=·05	25·0	30·1

Cotton, strain 5143, was planted on November 8th and good stands were obtained. The plants escaped the severe defoliation by grasshoppers which occurred in other sections of the Station and growth was fair. The low yield is attributable to the heavy attack of red bollworm, to bacterial bollrot and to a lesser extent to stainer damage in the late crop. The early onset of colder weather in April was also a factor in reducing the yield from the later formed bolls. Observations clearly indicated that this loss of late crop was in order of growth with KMP (B) ; KMP (A) and KM suffering in that order.

Growth.—Growth differences were always pronounced and the figures of plant weight from samples taken 61 days from planting show Nil (A) as significantly less than all other treatments. KMP (B) gave significantly higher plant weights than all other treatments.

Yield.—The yield figures follow the same trend as those of plant weight and, but for the shortening of the season, the differences would have been more pronounced.

The results confirm those of the earlier years of the experiment, but the differences are still more striking. It may be assumed that this accentuation is due to the building-up of residual effects.

Fertilizer Experiment (*B*).—This experiment, again planted to maize, is a continuation of that described under the same head in last season's report. The lay-out is on the loam and is designed to test the effect of nitrogen, phosphate and potash alone and in combination, the interactions being partially confounded.

Treatment.	*Rate per acre.*	*Yield per acre lb. grain.*	*Plant Wt. (36 days).*	*Witchweed per plot.*
Nil	...	1,070	25·8	1,402
N	200 lb. Nit. Soda	1,510	24·5	370
K	200 lb. Muriate	1,220	31·6	778
P	200 lb. Supers	2,140	44·6	688
NK	N plus K	1,270	23·1	323
NP	N plus P	1,860	39·7	231
PK	P plus K	1,790	48·6	757
NPK	N plus P plus K	2,200	48·4	319

The season was a poor one for maize and yields are low for the Station. Rainfall was never really safe and the crop suffered during the tasselling stage and later failed to fill out properly. The following is a summary of the main findings.

Yield.—Yields varied from 1,070 lb. per acre from the unfertilised plots to 2,200 lb. from NPK.

As in the previous season, the outstanding effect was that of P, while the effect of N was again significant. There was no interaction effect.

Growth.—The stimulating effect of phosphate on growth was early apparent. Samples for plant weights were taken 36 days after planting (17 days after applying the top dressing of nitrate of soda).

The plant weights show a highly significant effect of P. At the early stage of sampling there was no effect of N. Some effect was observable later and it is unfortunate that a heavy storm at harvest caused lodging and ruined the chance of obtaining corroborative figures from stalk weights.

Earliness.—Tasselling and silking records were kept. P showed a highly positive " earliness effect." N gave a negatively significant effect.

Witchweed.—The counts show again a significant decrease in the phosphated plots. Application of N also showed a reduction.

The figures are interesting as demonstrating the value of picking as a control measure ; the counts on the Nil series showing a reduction, following the previous season's picking, of over 90%. This affords corroboration of previous work here on witchweed control.

Fertilizer Experiment (*C*).—Following the results obtained in the factorial fertilizer experiment last season a further experiment was laid out on the granite section of the Station, using three levels of

N, P and K singly and in combination. The soil here is low in organic matter and poorer than the loam in all main plant nutrients.

The layout was planted to cotton to obtain data on yield, plant growth, and development, and on the incidence of *Alternaria*, which is particularly apparent on this soil. Two attempts were made to establish cotton ; the first germinated badly owing to crust formation following a heavy storm. The area was re-planted, but stands were affected by grasshoppers. This damage was likely to affect the experiment and, as the season was too far advanced for cotton planting, the area was finally planted to maize.

The treatments and rates of application were :—

K1.—150 lbs. per acre Muriate of potash.
K2.—300 „ „ „
P 1.—200 lbs. per acre superphosphate (18%).
P 2.—400 „ „ „
N1.—150 lbs. per acre nitrate of soda (Top-dressed)
N2.—300 „ „ „

The conditions were better for the maize than those in the experiment described above. Owing to the later planting the plants tasselled and silked in the excellent March rains. The following is a summary of the main features of the experiment.

(*a*) *Yield.*—Highly significant effect of phosphate, but no difference between P1 and P2. N gave a significant yield increase.

(*b*) *Growth.*—Samples for plant weight were taken 36 days from planting (21 days after application of nitrate of soda).

Highly significant increase from phosphate with P2, significantly higher than P1.

(*c*) *Yield of Straw.*—P, N and K gave significant increases in that order. P2 greater than P1 ; N2 greater than N1, but no significant difference between K2 and K1. Of the interactions only NP gave a significant increase.

(*d*) *Earliness.*—No significant differences in earliness as measured by tasselling were found, but indications of a delaying effect of the double application, N2.

(*e*) *Grain/Straw ratio.*—Both N and K show a significant decrease in the ratio of grain to straw. There was high significance between N2 and No, but none between N2 and N1 ; nor between N1 and No. K2 and K1 were both significantly lower than Ko.

(*f*) *Witchweed.*—The infestation was very slight.

From the results of these experiments on very dissimilar soils a number of points in common emerge. The importance of phosphate in increasing yield and in promoting earliness is indicated. Nitrate of soda in both cases gave increases in yield but tended to delay flowering.

Soil Restoration Experiment.—An experiment was laid out to test the effects of bush fallow and other crops in restoring fertility. The site of the experiment has been under cultivation for a considerable period and, before the land was taken over for experimental work, was unprotected from erosion and is in a low state of fertility.

The present experiment is designed to test the effects of a range of resting crops and varying terms of crop interruption, compared with a rotation of annual crops and with continuous cereal growing, the latter being a feature of native agriculture. The treatments are :—

Continuous maize.
Rotation of cotton ; maize ; legume ; maize.
Bush Fallow—two and three year fallow followed by maize.
Rhodes Grass—two and three years grass followed by maize.
Pigeon Pea—two and three years grass followed by maize.
Pigeon Pea and grass—two and three year periods as above.

The following notes indicate the poor productivity of the area, the reasons for the choice of regenerative crops, and the growth during the first season.

The site received no fertilizer and the average maize yield was 300 lb. per acre, against 1,100 lb. from unfertilized maize on the rest of the Station. Cotton also yielded poorly at under 150 lb. seed-cotton per acre.

Bush Fallow.—A feature of this series was that practically the whole growth was annual weeds. With the exception of isolated patches of *Cynodon* sp. no grasses were recorded.

Rhodes Grass.—This grass was used, not necessarily as the best for the purpose, but as being reasonably easy to establish and to plough out when cropping is resumed. Germination was patchy but by the end of the season the cover was fair and the grass had seeded freely.

In the series interplanted with pigeon pea, growth was less good, but should improve with the cutting back of the pigeon pea in spring.

Pigeon Pea.—This crop is included in the experiment as it grows well and past experience has demonstrated its value on worn-out lands in this area. It also supplies grain as food and grazing for cattle in winter.

Cotton Strain Trial.

A trial of a number of strains from the Barberton Station was planted in early November under favourable conditions. Germination was excellent, but in the period of hot, dry winds which followed, aggravated by defoliation by grasshoppers, the plants made poor early growth.

The crop was the lowest recorded on the Station, averaging 200 lb. seed-cotton per acre. The main causes were the very high infestation of red bollworm throughout the season and the considerable losses by bacterial bollrot following the wet and sunless period in March.

Temperatures fell considerably in April, and the plants made no recovery from the bollworm and bollrot losses.

The results obtained were of little value except as affording some corroboration of the Croydon trial.

Rotation Crops.

Maize strain trials.—Tests of progeny strains of the three most promising white flint families were planted both on the loam and on the granite. The rainfall conditions were unfavourable and the average yield of 1,600 lb. grain per acre is low for the Station. The granite soil suffered most and the season, though poor from the point of view of yield, was useful as a further test of the strains under bad conditions. With the exception of two strains which again disappointed, there were no significant differences between members of any of the three families. The tests here and at Croydon indicate little benefit from carrying on the numerous progeny strains, and it is proposed to simplify the work by a re-bulking of the best of these strains into three main strains. Further tests of these three strains will be made under as wide conditions as possible next season.

It has been stated in earlier reports that the white flint maize types were introduced for their capacity to crop better in the drier areas of the country and under poorer soil conditions than the dent types commonly grown. It is apparent from the tests that no further improvement is likely to result from further selection in this material and the work will not be continued.

In the more favoured rainfall areas Hickory King—a white dent type—is in most favour among farmers. No field selection has been done on the crop here and there is no doubt that much of the poorer material could be eliminated. A large number of cobs have been selected this season and it is intended to continue the work next season.

Kaffir Corn.—Work was confined to mass selection in bulks of the five main strains. Four of these are very similar in plant characters and, as recent tests both here and at Croydon have revealed slight and inconclusive yield differences, it is intended to bulk these strains.

The fifth strain—P127—is a stout-stemmed type with a plant height of only 3 feet. In a number of tests during the past few seasons it has yielded very little less than the bigger strains, and is very resistant to lodging.

A combined strain and row-width experiment was carried out and the results indicate that the standard row width of 36 inches is too wide for these dwarf kaffir corn strains. In all cases there was an increase in yield in 30-inch rows ; the increase being greatest in the case of the very short-stemmed P127. The experiment will be repeated with a larger range of plant densities.

Soya Beans.—A trial was carried out including a number of promising strains of soya beans obtained from Potchefstroom and the

Y1 strain which has been in cultivation here for some time. Conditions for growth and fruiting were not good and yields were low. Three of the introductions were very early maturing and yielded poorly, and only one of the strains outyielded Y1.

Miscellaneous Crops.

As in previous seasons a number of crops were grown which had been introduced for food or on which experimentation has been terminated.

Sunflowers.—The black and the grey striped varieties which have done well in the past were carried on and mass-selected to maintain seed supplies.

Sunnhemp.—The crop is widely grown as a green manure crop and on the Station to provide material for compost. Growth was satisfactory, amounting to close on 10 tons green matter per acre.

Groundnuts.—Germination and growth were good, but the crop had unfavourable conditions during flowering and yields were not high. Groundnut prices have advanced materially and there is a large demand for seed of the improved types.

Sweet Potatoes.—This is a favoured food crop, but the varieties in present cultivation are generally late maturing and low yielding. Recommended varieties from other African colonies have been obtained for trial and introduction to natives if satisfactory.

Cassava.—This crop has been grown on the Station for some time as a source of food and to supply planting material. The Station labour readily eat the roots and the leaves, and it is hoped that the crop will become more widely known and grown in the native areas. Among the Swazi people food shortage is the rule and the family cassava plot would afford supplies when grain crops are short.

Pigeon Pea.—This has been established as regenerative cover on poor land. It yields a fair crop of grain and grazing for cattle. Like cassava. it promises to be a useful semi-permanent crop in the native areas.

CROYDON STATION.

This sub-Station was started some years ago on Government land some 35 miles north of Bremersdorp. It is hotter and drier than the latter place and is about 1,000 feet lower. The site selected as the most convenient one representing in soil and climate a large portion of the potential cotton-growing area. The soil is a light, sandy loam and had been subjected to the rigours of native cultivation and was in consequence denuded of fertility, infested with witchweed and generally unproductive.

Meteorology.

The rainfall for the year was 28 inches, but the distribution was not ideal. Cotton had ample moisture except for a disastrous dry spell in February, when there was heavy shedding of the top crop. Kaffir corn did well, but the season was less satisfactory for maize.

Ploughing was completed early, but planting was delayed until the heavy rain of late November. Conditions for planting and early growth were good and crops established well. February was critical for maize and the long dry period adversely affected yields. By February cotton prospects were excellent, but the rain of early March was too late to save the top crop and heavy shedding occurred. Recovery of the cotton was poor after this shedding, owing to an attack of red bollworm, to the lack of moisture in April, accompanied by the onset of colder nights, and to an increase in the stainer population. The period of effective crop production was short and the average yield of 350 lb. lint per acre is considered excellent in the conditions.

AGRICULTURE.

Fertilizer experiments were carried out both with cotton and maize. As at Bremersdorp, all combinations of N, P and K were included in the layout, in which all interactions were partially confounded.

Fertilizer Experiment (*A*), *Cotton.*—This is a continuation of the experiment described in last season's report ; the layout then being planted to maize.

Cotton was planted on December 2nd in excellent conditions and stands and growth were good. Conditions remained good until the latter part of February. At that stage the plants were carrying a good crop of bolls, but the prolonged dry spell led to considerable shedding and to a cutting down of flowering. Bollworm damage was higher than in the past few seasons. No rain fell in April and by the end of the month the plants showed the effects of water shortage and this, together with the onset of colder weather and an increase in the stainer population, reduced the late crop. The yield over the whole experiment was 330 lb. lint per acre.

Yield.—The results show a highly significant yield increase from P and a significant decrease from K. These effects are contrary to those observed in the same experiment with maize last season and in a maize experiment described later. In both instances the effect of P was inconsiderable, while N and K gave substantial increases in yield. The effective flowering period was short and it is suggested that the apparent contradiction of the results is due to the effects of the treatments on flowering rate.

Growth.—Sampling was done at 42 days from planting (26 days after applying nitrate of soda). Differences were in general small, but K showed a slight negative significance. At ten weeks growth increase was observed on the N series.

Ginning percentage and seed weight.—Treatment effects were inconsiderable.

Flowering.—The total for the season showed a reduction in flowering from K and to a lesser extent from N. The totals from the early flowering period, which was responsible for almost the entire crop,

indicate an effect of P in promoting early flowering while K and N show a delaying effect. Somewhat similar results were recorded in the maize experiments at Bremersdorp.

Fertilizer Experiment (B), Maize.—An experiment similar to the one described above was planted to maize. Phosphate and potash were applied broadcast and ploughed under in winter. Nitrate of soda was applied as a top-dressing 19 days after planting. Planting conditions were good, but stands suffered from cutworm damage. Conditions later were dry, particularly at flowering, and yields were reduced.

Yield.—The yields ranged from 970 lb. per acre from the unfertilized plots to 1,400 lb. from NPK. N gave a significant yield increase, while the increase from K just failed to be significant. Though less definite than in the previous season the results are corroborative.

Growth.—Treatment differences were early observable and samples were taken at about four weeks after planting. Owing to loss of stand from cutworm attack, the plant weights may be less reliable than those of the previous year. The trend was similar; K again giving considerable increases with N somewhat lower. It should be noted that in all these experiments plant samples were taken before the effect of the nitrate of soda had become fully apparent.

The varying nature of the results from the two Stations was mentioned in the report of last season and the same trend is again marked. In the Bremersdorp experiments, both on the loam and on the granite, the main factor in increasing the yield of maize was phosphate, while in those at Croydon potash and nitrate of soda were more important.

The results with cotton were markedly different and it is hoped to obtain fuller data from the experiments proposed for next season.

Cotton Strain Trial.

The trial described in the Bremersdorp section was duplicated at Croydon.

Planting was done in early December in good conditions. This is considered somewhat late as it leaves the crop more liable to stainer damage and to a restricted season through falling temperatures in April. Early conditions were good and the crop established well. By mid-February an excellent crop of bolls had set, and with the good " top " of young bolls showing, a record yield for the Station appeared probable. By the end of February water shortage became apparent; the fall of rain in early March was just too late to save the top crop and considerable shedding occurred. This loss was vital as the bolls formed from later flowering produced little crop owing to the early close of the season through falling temperatures in April and the increase in the stainer population. The average yield of 350 lb. lint per acre is excellent in view of the short effective flowering period.

The yield differences were in general very narrow. Only one strain—of the 921 family—yielded significantly higher than 5143, which is now the standard strain in general cultivation.

The only other substantial difference was that of the 920 derivative, which was lowest in yield and generally unattractive.

Rotation Crops.

Maize.—The trial of the white flint strains was duplicated at Croydon. The season was unfavourable and the average yields were 1,100 lb. per acre. The rather poor conditions were welcome from the point of view of eliminating strains not suited to the rigours of native cultivation.

In the Bremersdorp section it was noted that selection work on this material is being discontinued, the strains being bulked into three main families. These white flint strains are popular in the area and all available grain is reserved for issue as seed.

Kaffir Corn.—As at Bremersdorp, strain and spacing tests were carried out. The crop was more suited to the conditions than was maize, and yields of 1,900 lb. per acre were reaped. The results corroborated those of Bremersdorp, both as regards strain performance and as indicating the value of a higher plant density than has been employed in the past.

Forestry.

In the high- and mid-veldt areas satisfactory afforestation is easily accomplished. Eucalypts provide an easily grown source of poles or firewood and wattle supplies material for hut building, while pines, cypresses, etc., also grow well. In the drier areas such as Croydon, eucalypts and wattles are not successful. Termite attack is also a factor to be considered.

Reasonably quick-growing timber for native hut building, for poles and for firewood is a problem and is leading to a cutting out of slow-growing indigenous trees. In collaboration with the Forestry Officer an experimental area has been planted with plots of tree species which may be suitable. Earlier introductions of *Cassia siamea* and *Cedrela toona* are promising, but the present plots include, in addition, a number of species of pine, cypress, *Callitris*, etc., which have done well in dry areas elsewhere.

The plots also provide for observation on the relative merits of "pit planting" in the natural veld and planting on ploughed land.

Miscellaneous Crops.

As at Bremersdorp, a number of crops are grown as bulks for food, etc. The range is substantially the same at both Stations.

Summary.

(1) The season was marked by fairly high, but poorly distributed rainfall; a short cotton season at both Stations, and the heaviest

red bollworm attack for many years. This attack was lighter at Croydon, that Station also being free from the bacterial bollrot which reduced the Bremersdorp crop.

(2) Cotton strain tests carried out in conjunction with the Barberton Station are reported.

(3) A series of Fertilizer Experiments were conducted at both Stations. These were mainly on maize, owing to the difficulty in establishing satisfactory stands of cotton at Bremersdorp. The experiments are described and a summary of the main findings given. The results with maize confirm those of the previous season.

(4) Strain tests of white flint maize and of the early-maturing kaffir corn lots were carried out. As a result this work has been simplified by the discarding of some strains and the bulking of others which have again shown yield and growth similarity.

(5) Combined strain and row-width trials with kaffir corn indicated the value of a closer spacing than has been used hitherto.

(6) The layout of the soil restoration experiment is described and the growth of the various crops noted.

(7) A range of other crops was grown. Soyas and groundnuts were affected by lack of rain at flowering and yields were low. Sunnhemp and velvet beans grown for hay and as material for compost yielded good crops of green material.

PROGRAMME FOR THE SEASON 1942-43.

BREMERSDORP AND CROYDON.

1. Cotton strain trials will be continued.
2. The fertilizer experiments described in the present report will be carried on as follows :—

   (*a*) The combined fertilizer and rotation experiment at Bremersdorp will be planted to maize. This will be the fifth year and, in addition to the fertilizer effects, evidence will be available of the rotational effect of cotton on the maize crop.

   (*b*) The factorial fertilizer experiments (B) and (C) at Bremersdorp will be planted to cotton. Both were under maize in the past season and are laid out on the loam and granite soils. Growth and development records will be taken. *Alternaria* is prevalent on the granite soil particularly and the experiment will afford opportunity to determine the possible effects of fertilizers on leaf holding.

(*c*) Similar experiments to the above—one planted to maize and one to cotton—will be carried out at Croydon as in the past season. In the accompanying report dissimilarities in treatment effects on the two crops were noted. The continuation of the experiments is necessary to clarify the position.

3. The soil restoration experiment will continue on the lines described in the present report.

4. Work on white flint maize and on kaffir corn has been simplified by the re-bulking of progeny strains. Trials of the main families will be continued for one year. The present season's work has indicated that the kaffir corn strains will benefit from closer spacing and combined strain and row-width trails will be planted.

5. It is now apparent that no further material benefit will arise from selection in the white flint maize lots and this work has been discontinued. These types are intended primarily for cultivation in the drier areas. In the areas of more favourable rainfall Hickory King, a tall, later-maturing dent variety, is commonly grown. Some preliminary selection on this variety is proposed.

6. Strain tests of soya beans will be continued.

NOTE ON NATIVE COTTON PRODUCTION

BY

H. HUTCHINSON.

At the end of 1940–41 the prospects for the next cotton season were encouraging ; some 80 natives had grown the crop and though the average yield was low, this was largely due to the complete failure of about 25% of the acreage owing to the relegation of cotton to the most worn-out soils and to extremely poor cultivation. In many cases quite good yields were obtained and the return was sufficient to introduce the idea of a cash crop, though the natives generally have little ambition to earn money and raise their present low standard of living. Interest in the crop, however, was more definite and widespread than ever before.

Unfortunately the 1941–42 planting season was most unfavourable. No winter ploughing had been possible ; early rains were short and were followed by two months' drought, as a result of which the natives were anxious about their food crops and many intending cotton growers banished all thought of cotton from their minds until it was too late to plant. In spite of this, cotton was planted by about 90 growers, an

increase in numbers over the previous year of about 10%, though the total area of 90 acres showed a drop of 25%, the latter being due to the defection of several chiefs and the collapse of a native scheme for communal crop cultivation for the benefit of the Swazi royal house, in which cotton was one of the crops in the rotation. The loss of this dead weight, however, is expected to make the industry more buoyant, especially as there are signs that those who now plant cotton intend to cultivate it properly to get a useful cash return. It may be noted that European farmers also found the planting season a difficult one for cotton and very little was grown.

After general late planting the growing season developed into a long catalogue of misfortunes, including drought, punctuated by violent local storms which caused erosion and packing of the surface soil over germinating seed, hail and intense heat killing off young seedlings. Severe drought in February was followed by three weeks of almost continuous rain in March, during which growth was stopped by cold weather ; serious shedding was caused and infection by bacterial boll rot became common. In addition there was a heavy general attack by red bollworm. (The weight of this infestation may have been due to accelerated multiplication of the pest owing to the intense heat promoting higher rates of development at all stages.) Severe drought in April was again followed by heavy rains which damaged the ripe crop so much that a good deal of it was not picked. In these circumstances the wonder is not that yields were low, but that any cotton was picked at all, and it was surprising to see the excellent condition in which most of the crop was brought in.

The total production was 11,215 lb. of seed cotton of which 10,581 lb. were from private individuals' own fields, the average yield being 118 lb. per acre, compared with 21,941 lb., 14,159 lb. and 186 lb. per acre respectively, in the previous season. In both years some 25% of the initial acreage failed from a variety of causes, including destruction by free-grazing cattle in the autumn. On the whole, cotton made a good showing in comparison with native food crops, among which maize in many localities produced hardly anything at all.

The low cotton yields are a fair indication of the lack of agricultural skill among the natives, especially when it is considered that those who do not grow cotton probably have less ability and are less receptive of ideas than those who do, but there are signs that cotton growers are beginning to appreciate the value of cotton as a rotation crop for grain and the benefit that the better cultivation given to cotton confers on the succeeding crop. In addition, every effort is made to lead growers on step by step to strip cropping and rotation, use of kraal manure, real soil preparation and proper cultivation, the use of contour banks against soil erosion and so on. Given a favourable planting season, which means frequent rains and ample opportunity for the native in his own leisurely fashion to plant all his food crops in good time, there should be a considerable amount of cotton grown in native areas, and the prospects for 1942–43 are still considered to be encouraging.

SUMMARY.

The results of the 1940–41 season were such as to encourage the hope that the number of cotton growers would increase to several hundreds, but the unfavourable planting season kept the number down to 90, an increase of only 10%.

The acreage fell by 25% and owing to the very adverse season the average yield per acre fell from 186 lb. to 118 lb.

Total production was 11,215 lb. compared with 21,941 lb. in the previous year.

SOUTHERN RHODESIA.

Introductory Note

BY

G. S. CAMERON.

Early in the present century an attempt was made to grow cotton in Rhodesia on a commercial scale, but without success. After the last war renewed efforts were made and good results obtained in the 1923–24 season when prices were exceptionally high. The combination of one good year, and high price levels, precipitated a rush into cotton-growing which proved disastrous, and undermined confidence as to the suitability of the country's soils and climatic conditions for the commercial growing of cotton. The discovery of a cotton suited to the country restored some of the lost confidence, and had prices remained at a reasonable level, it is quite likely that a steady increase in production would have developed. Low and fluctuating prices, however, made it very difficult for cotton to make headway, especially when other primary products were assisted by control measures, preferences and bounties. But for the perseverance of the Government, the Empire Cotton Growing Corporation, and a number of enlightened growers, cotton-growing would have come to an end, and it is very doubtful if any further efforts to revive the industry would ever again have been made in view of past difficulties and failures. Only the best grades could stand the cost of transport to the coast, and freight to Liverpool or the Continent, while the lower grades and shorter staple cotton had to be sold locally at best.

There arose, also, the paradoxical situation that low grade cotton and linters, sold on the local market, realised much better prices than the best cotton shipped overseas. At the same time, piece goods manufactured from inferior Asiatic cotton and imported into the Colony maintained a high price level.

The war brought matters to a head, as shipping space had to be curtailed, and it then became obvious that the sensible thing to do would be to manufacture Rhodesian-grown cotton in Rhodesia, and thus save double shipping space, (*a*) on the raw material going forward for export, and (*b*) on return, by importation of the manufactured article. For this reason the Government of Southern Rhodesia decided to manufacture absorbent cotton wool, which would supply local requirements, and, if need be, those of neighbouring territories. At the same time it was decided to erect a spinning mill, and commence spinning cotton to absorb the locally grown crop. The linters and soft staple cotton will go to the manufacture of absorbent cotton wool while the spinning mill takes up the remainder, the best part of the crop. In order to ensure that sufficient cotton would be grown to supply the spinning and cotton wool industries, the Government guaranteed prices to growers for a period of five years. The response

to this gesture on the part of the Government was instantaneous, and in one year the cotton crop has increased over five-fold. This ready response to planned production on the part of the cotton growers augurs well for the further development of the cotton-growing and manufacturing industries. The intention at present is that the spinning of cotton will be the responsibility of the Cotton Research and Industry Board, while private enterprise is expected to take up the output of spun yarn and convert it into woven and other finished products. This policy appears to be amply justified, and, already, indications are that there will be sufficient looms in operation to take up the total output of the spinning mill early in 1943. Looking further ahead to the period of post-war reconstruction, in the settlement of ex-servicemen and industrial development cotton is destined to take an important part. The more it is processed and used in the country of origin, the more valuable it becomes to the country. There are very few areas in Southern Rhodesia that are entirely unsuited to cotton. In fact it may be stated that the Colony, as a whole, is more suited to the growing of cotton than to that of any other agricultural product, provided the latter is not subsidised directly or indirectly as in the past. There is ample evidence now to show that such is the case, yet it is doubtful if this evidence would have been available but for the patience of, and the persevering work undertaken by, the Empire Cotton Growing Corporation, operating over a long period in close co-operation with successive Governments of the Colony. Each year bears witness to the sterling work of the Corporation's plant breeding staff at Gatooma, prior to their transfer to Tanganyika Territory; and it is equally true to say that the best was got out of them by the ever helpful, and encouraging attitude adopted by the Rhodesian Administration.

COTTON STATION, GATOOMA.

PROGRESS REPORT FOR THE SEASON 1941-42.

This report of the Gatooma Cotton Station is brief and, it is feared, sketchy. A fair amount has been attempted, perhaps too much, because it is felt that a useful quantity of evidence has been collected, but insufficiently sifted out and analysed. Such must of necessity be the case where activities have increased in inverse ratio to decrease in technical staff. Strain trials, plant selection work, and the multiplication of improved strains have been given priority over everything else mentioned in the report which, however, does not deal with much that has been done, but does not come within its scope. As organised at present, the staff falls far short of actual requirements, and it is feared this state of affairs may have to continue for the period of the war. Thereafter, it is hoped that it may be possible to expand some promising lines of investigation which may be of considerable use locally to the growing as well as the spinning and manufacturing industries.

Meteorology.

The season opened favourably for cotton with over 2 inches of rain by the 22nd October, and good planting rains in the beginning of November. This early promise of a good season was not maintained however, and eventually it developed into one of severe drought in most parts of the colony, and very severe drought in Matabeleland. The temperatures were high throughout the growing season, and well into the autumn. The rainfall in November, December and January was good and well distributed, but in February and March light and scattered showers were mostly ineffective. The total rainfall amounted to 21·79 inches as compared with 33·20 inches and 46·23 inches in the immediate preceding seasons.

Agriculture.

Maize crops throughout the country ranged from very poor to complete failure in parts of Matabeleland. Cotton lived up to its reputation of being able to withstand prolonged droughts, however, and except for severe attacks of sore-shin fungus, which reduced the stand of plants severely in the early part of the season, the crop did not encounter many hazards. It opened much earlier than usual, and some of the earliest strains on the Cotton Station were beginning to open by the end of February. This extreme earliness caught many growers unawares, among them the Cotton Station at Gatooma. Picking should have commenced and been finished by the end of April, if labour and other conditions had allowed. As it was, picking had to be delayed until June, by which time the cotton was hanging on the plants in festoons, blown about in the wind, and a fair proportion on the ground. All this meant a lowering of grade, which, under the circumstances was unavoidable.

The acreage planted to cotton on the Gatooma Station was increased to 172 owing to the necessity of multiplying up five strains which were undergoing trial. Three out of the five have been discarded, and two retained, *viz.* :—(i) 9L18 for bulking on a commercial scale by selected farmers, and (ii) 9L34 to be further bulked up on the Cotton Station. The former, 9L18, yielded sufficient seed to plant about 600 acres on various farms scattered throughout the country, while the latter, 9L34, will plant about fifty acres.

The present intention is to replace 7L1, the strain now in general cultivation, by 9L18, and to have 9L34 to follow unless something better shows up after the next two seasons.

Cotton yields were good, except on the widely spaced multiplication blocks where the object is to increase seed supply in preference to obtaining a heavy yield per acre. The following table shows the variations in yield of seed cotton per acre according to the purpose for which it was grown.

Purpose.	*Yield : lb. seed cotton per acre.*
Variety Trials	1,160
Commercial Crop 7L1...	719
Progeny Rows, severely rogued	669
Seed Multiplication blocks	278

The following strain trial was carried out on composted, and non-composted land. Each variety was replicated twenty times in strips 120 feet long.

FIELD B.A.

Composted.		*Not Composted.*	
Variety.	*Yield seed cotton lb. per acre.*	*Variety.*	*Yield seed cotton lb. per acre.*
9L34	1,192	9L34	908
6C6	1,182	6C6	903
9L18	1,091	9L18	797
7L1	957	9L26	761
9L26	953	7L1	661
9L36	900	9L36	561
Lowest significant difference (P=·05)	94	Lowest significant difference (P=·05)	73

The figures from the above trial were converted to a "Yield per 100 Plants" basis without materially altering the order of priority of the strains.

The trials laid down two years ago, in which an attempt to assess the rotational benefit of cotton to a succeeding maize crop on poor land, composted, and not composted, were concluded. The results are as follows :—

PLAN 1.

Not Composted.	*¼ acre Plots. 8 Replications.*
Maize after cotton	2,060 lbs. per acre.
Maize after maize	1,800 „ „ „
Difference	260 „ „ „
L.S.D. (P.=·01)	95·2 „ „ „

PLAN 2.A.

Compost harrowed-in for previous season's crop.	*⅛ acre Plots. 4 Replications.*
Maize after maize	3,120 lbs. per acre.
Maize after cotton	2,360 „ „ „
Difference	760 „ „ „
L.S.D. (P.=·01)	136 „ „ „

PLAN 2.B.

Compost ploughed in for previous season's crop.	*⅛ acre Plots. 4 Replications.*
Maize after maize	2,933 lbs. per acre.
Maize after cotton	2,537 „ „ „
Difference	396 „ „ „
L.S.D. (P.=·01)	98 „ „ „

The above result of Plan 1 is about what one would expect from the experience of former years. The differences between maize after composted maize, and maize after composted cotton are definitely contrary to expectations, but have to be accepted until the experiment can be repeated, if possible on soil of about equal fertility, but on a different part of the Station.

Cotton crops throughout the districts were well above average, with the exception of those districts where drought conditions were very severe. The quality of both lint and seed was also much better than in most years. It is anticipated that there will be a further increase in cotton acreage next season, but there is no tendency this time to rush matters as happened previously.

It is with regret that one has to record the loss of a large part of the crop through fire at the Gatooma ginnery at the end of August. It was not so much the value of the cotton that mattered, as the loss of the commodity itself, representing as it did the efforts of farmers from every part of the country. Fortunately no seed was lost and no damage done to buildings or machinery.

Livestock.

Owing to the reduced maize acreage on the Cotton Station, there was not sufficient maize stover to feed as many bullocks as usual. In consequence there will be a much smaller amount of compost for the following season, a position that should not be allowed to occur again. Only 30 steers were fattened. Of these 24 were purchased by the Cold Storage Commission and graded out much better than usual. One reached the highest grade which sells at 45s. per cwt., and the remainder sold at 42s. per cwt.

Implements and Machinery.

Work on the design and manufacture of a reliable compost spreader has had to be abandoned. The low loading wagon mentioned in previous reports, constructed for the collection of farm waste, continues to give satisfactory service.

Genetics and Breeding.

As already mentioned, 7L1 is the strain in general cultivation, and it has done very well in different parts of the country, and in seasons of opposite extremes. By the time it is possible to get out a new strain, however, it is likely that 7L1 will have outlived its period of usefulness, and it is hoped that the two " follow on " strains, 9L18 and 9L34, will prove equally adaptable to varying conditions. 9L34 is the better strain of the two, but 9L18 is in a much further advanced stage of multiplication. 6C6 is a hardy, good yielding strain, but not yet sufficiently uniform to bulk up for general cultivation. Probably for this reason, it offers good material for re-selection and many promising single-plant selections have been taken from it. 9L36 is a short-stapled, early maturing variety which catches the eye on account of its earliness, spectacular appearance, and general capacity for window dressing.

The following table gives an interesting comparison of the staple lengths of some of the more prominent cotton strains as determined by Balls's Cambridge Sledge Sorter.

	Varieties.					
	7L1	6C6	7L5 DC 5/1	9L18	9L34	9L36
Length.	*Percentages.*					
½"	—	—	—	1·73	·17	·93
⅝"	2·06	1·05	·34	2·60	2·11	2·26
¾"	5·21	1·69	·50	5·21	4·22	3·44
⅞"	7·08	3·69	·90	6·95	7·04	9·23
1"	14·01	10·13	12·13	11·30	10·56	13·86
1⅛"	18·88	17·15	20·50	15·65	11·97	19·40
1¼"	19·82	27·82	26·50	26·08	14·08	23·54
1⅜"	21·83	27·73	25·30	21·73	23·23	14·03
1½"	10·08	7·13	13·30	8·69	20·42	6·87
1⅝"	·98	2·46	·36	—	5·63	4·89
1¾"	—	1·08	—	—	—	1·41

It is a matter of great regret that time and staff limitations did not permit of more attention being paid to the progenies of some of the colchicine and other plants " doctored " in the 1939–40 season. Some of these have continued to show prolific flowering and fruiting into the F_3 generation, and it is hoped that there will be sufficient seed of some of them to allow their inclusion in a strain trial. For Rhodesian conditions a prolific flowering type of cotton is essential on account of American bollworm. The trouble with prolific flowering types is that they produce very small bolls, and this slows down the rate of picking. One such type produced this season a medium-sized plant, 70 cms. in height, which averaged 17 flowers per plant per day over three days, with an average of 5 flowers per plant per day over 53 days. About one-third of these flowers set and produced small roundish bolls, but unfortunately the lint was soft in character.

The progenies of the acenapthene-treated native plants mentioned in last year's Report are rather interesting. Unlike native cottons, they grew very quickly, their energy going to length with hardly any branching. Very few flowers were produced, and only one developed into a distorted looking boll. Several plants, one in particular, produced two types of leaf, (1) the small round-lobed leaf characteristic of native cotton, and (2) a very much larger leaf of the same shape. Photographs of these plants are available for anyone interested in curiosities of this type.

Single-Plant Selections.—Over a thousand single-plant selections were made in the field. Actually this is far in excess of what should have been taken, but it was difficult to do otherwise owing to the wide range of material from which to select. There was an accumulation of over thirty blocks of crossed material (the 7C's) which was carried over from 1938, and which had to be examined. These required a lot of attention as, like the 6C6's, they were splitting in all directions. Over half the single-plant selections taken in the field were rejected after laboratory examination, mostly because they were lacking in lint character, and inclined to softness. There is a tendency towards softness of staple in Rhodesian cottons, against which it is necessary to be perpetually on guard.

The Station crosses, the 7C's, grew vigorously from the start and developed into uniformly large plants, coarse, rank, and generally

very hairy. Most of them were highly resistant to jassid, but relatively few possessed good lint. Those that did have good lint were usually of the very bushy, vegetative, large-leaved type.

Taken as a whole, they make an excellent reservoir for re-selection purposes, and it is quite likely that future seed stocks will be derived from them.

Perhaps their chief drawback, up to the present, is their amount of leaf, which affords shade, particularly for stainers.

Entomology.

Locusts.—For the second season in succession locusts have done no appreciable damage.

Jassids.—Jassid attack was much earlier than usual, and probably reached its peak before records were started. This was about the middle of February and numbers diminished rapidly until, by the third week in March, they disappeared. The resistance to jassid, which has been bred up steadily in Rhodesian cotton, has reached a stage when this pest is no longer a serious one, or so it would appear. Also, the prevention of ratooning may have helped to reduce their numbers by reducing their breeding grounds and the length of time in which to breed. It would be a mistake to conclude that jassids no longer constitute a danger, and the necessity of continuing to breed jassid-resistant strains must ever be kept in mind.

Bollworms.—American, Sudan, and Spiny bollworms were all present about the same time, but in very limited numbers. The cotton was planted early, and this may account for the very slight loss from bollworms. Again, it may be the prevention of ratooning that is responsible for the diminution of all insect attacks.

Stainers.—*D. fasciatus* appeared in small numbers in February, reached its peak about the end of March, and disappeared in April. *D. intermedius* and *D. superstitiosus* were in evidence from the middle of February to the end of March, but their numbers were negligible. Being an exceptionally dry season, it may be that the low humidity lessened the damage which, otherwise, might have been caused.

Aphis.—Was not much in evidence at any time throughout the season.

Termites.—Much termite damage to plants was caused towards the end of the season. Some fields appear to be worse than others, and certain parts of the Station will have to be avoided for the purpose of growing progeny rows, strain trials, or small bulk plots.

Mycology.

For the second season in succession there was very little Angular Leaf Spot, and no evidence whatsoever of Blackarm.

Early in the season, during one of the drought periods, and in the early seedling stage, stands were reduced by severe attacks of sore shin.

Summary and Conclusions.

The season was characterised by severe drought periods, but cotton yields were well above average, and the crop opened early in comparison with past seasons.

The results of strain trials are given ; two possible strains have been selected to follow 7L1 for future seed issues.

A maize–cotton strain trial has been completed, with partly unexpected results.

The fattening of young steers was continued with highly successful results.

F_3 progenies of " doctored " plants are discussed on account of their sustained prolific flowering, and mention is made of the progeny of a native cotton subjected to acenapthene treatment.

Rather too many single-plant selections were made, but under circumstances which justified doing so.

Very little damage was done by insects and the theory is advanced that anti-ratooning measures have been effective.

The only disease to be recorded was sore shin in the early part of the season.

PROGRAMME FOR 1942-43.

Owing to scarcity of maize in the country it is intended to grow as large an acreage as possible on the Cotton Station. As much of the land requires to be green manured, it will be necessary to cut down the cotton acreage. This is going to be difficult owing to the area required for single-plant selections, progeny rows, and small bulks. The strain 9L34 will be multiplied one stage further.

It is intended to carry out a strain trial on the same lines as last year, but substituting three new strains for the three which have been discarded.

It is hoped that it will be possible to cut down single-plant selection work to a limited extent. Records will be taken of insect populations, and plant development as formerly. Much time will have to be given to activities which do not come within the compass of this report.

ANGLO-EGYPTIAN SUDAN.

PROGRESS REPORT OF THE PLANT BREEDING STATIONS, SEASON 1941-1942.

Introduction.

Staff.

By arrangements made between the Empire Cotton Growing Corporation and the Sudan Government, Mr. H. E. King, the Senior Plant Breeder, was temporarily transferred for duty to Barberton, South Africa, and Mr. R. Anson appointed Acting Senior Plant Breeder for this period. Under Mr. Anson's general supervision, Mr. R. L. Knight has continued to live at Shambat and to be in charge of the Blackarm resistance project ; Mr. Evelyn continued to live at Medani and to develop his selection and breeding work on dura ; Mr. Anson transferred from Kadugli to Wad Medani, but has spent a good deal of his time in Kordofan.

Summary of Progress.

Blackarm (*B. malvacearum*)—Resistant Strains.

The 9th backcrosses of N.T.2 and X1730 types were grown and seed produced for sowing propagation plots at Shambat next season.

Seed of the 7th backcross of N.T.2 type was produced in sufficient quantity to enable a 45-feddan increase area to be sown at the Seed Farm of the Sudan Plantations Syndicate in the coming season, in addition to a series of plots for testing.

Seed of the 7th backcross of X1730 type, sufficient for testing in the Gezira and sowing in a ten-feddan propagation plot, was produced.

Small quantities of other types were produced for inclusion in 1942–43 tests. These included an N.T.2 backcross homozygous for both factors $\mathbf{B_1}$ and $\mathbf{B_2}$, and therefore highly resistant to Blackarm.

The 6th backcross stage has been reached with crosses involving factor $\mathbf{B_3}$ which is expected to confer a still greater measure of Blackarm resistance.

The addition of a gene conferring reddish flowers and leaves has been continued with and has reached the 9th backcross stage.

Other Strains.

Crosses between Sakel and Tanguis, made in order to transfer the hairy leaf of the Tanguis strain to a plant of Sakel lint quality with a view to promoting jassid-resistance, have been taken to the 3rd backcross stage and are being proceeded with.

Work carried out at the Central Station on leaf curl resistance is progressing favourably.

Three promising strains of American cotton are being bulked for further testing, and several promising selections from S.P.20 and S.P.84 (both Uganda cottons) have been isolated and will be tested in the Equatoria Province.

Some 335 types of dura have been collected and the most promising of these are being tested in both irrigation and rainfall areas.

GEZIRA RESEARCH FARM.

Meteorology.

The total rainfall for the year was 279·3 mm. as compared with an average of 402 mm. taken over a period of 22 years. This shortage has been general and applies to all stations in the Gezira.

Cotton Breeding Work (S. H. Evelyn).

The Breeding Plot.—This season, a single row of 26 plants of each selection was grown. The single row was adopted in place of the former progeny plot of 60 plants (six rows, each of 10 plants) to reduce the high degree of soil variation within progenies, which, in the past, has made selection a hazardous undertaking. The progeny lines were separated by alternate rows of Massey's Selected Domains Sakel (M.S.D.S.) and X1730A to facilitate field comparison. M.S.D.S. has little resistance to leaf curl disease and so is useful as a " spreader". Selections from the N.T.2 and X1730A series, Commercial Domains Sakel, Original X1730, M.S.D.S., and Sakel from U.S.A., were studied alongside their parent controls. In their first year (1940/41) the Sakel strains from America proved inferior to Domains Sakel. Although work on the purification of M.S.D.S. continues, the original stock is being maintained as a reservoir of useful material. Selection for improved quality in the X1730 series proceeds.

Selection for Leaf Curl Resistance.—In continuation of the work referred to in the last Progress Report, progenies were selected which showed little or no infection under the low leaf curl incidence which obtained in 1939/40. The selfed seed of the " free " plants of each of the fourteen selected progenies was bulked separately. No individual plant selections were made.

The test this season took the form of a randomized block experiment with eight replicates, and contained 13 selections from M.S.D.S., one from N.T.97/40 and three further selections made by Knight at Shambat from N.T.97/40 and a bulk re-selection from it. Unselected M.S.D.S. was employed as a control. To reduce soil fertility effects each progeny plot consisted of a single row, and to facilitate the spread of the disease each alternate hole in each row was

sown with unselected M.S.D.S. in such a manner that each selected (or R) plant was surrounded by likely susceptible or " spreader " (S) plants as is illustrated in the accompanying diagram.

R	S	R	S	R	S	R
S	R	S	R	S	R	S
R	S	R	S	R	S	R

On the advice of the Acting Senior Plant Pathologist, sowing of the experiment was delayed until mid-September as past experience at G.R.F. had shown that late-sown cotton was more liable to attack than cotton sown at the normal date of mid-August.

A shortage of seed of many of the progenies necessitated employing a low seed rate and this disadvantage, together with late sowing and a fairly heavy termite attack on the seedlings, resulted in the loss of 8·75% of the total number of plants. Although not seriously affecting the main results, it was observed that plants to the leeward of blank holes either took longer to contract the disease or remained free from it up to the last count. A similar result was observed for " spreader " plants to the leeward of truly resistant plants. Growth, because of late sowing, was slow, and in general the plants displayed little vigour throughout the whole period of the experiment; nevertheless a high leaf curl infection was obtained and it was not found necessary to adopt the usual practice of cutting back the plants to induce new vigorous growth and so encourage attack.

The experiment was sown on 13th September, 1941, and leaf curl counts taken on 19th March, 1942, 31st March, 1942, and 21st April, 1942. Although a small amount of secondary growth was in evidence at the time of the last two counts it was never vigorous.

The experiment occupied the two northernmost angles of the Breeding Plot and was bounded on the north by a five-feddan fallow area, on the east by a residential garden, and on the west by a fallow plot of the " Observation Experiment". Except, therefore, for the contiguous cotton of the Breeding Plot due south of the site, and the cotton of the " Observation Experiment " which was a fair distance away to the south-west and was separated from the site by a fallow area, a belt of *Cajanus* and a small plot of *Dolichos*, there was no other cotton nearby. The Breeding Plot had an infection of only 3·4%. The " Observation Experiment " showed 78% at the end of February, 1942, and routine counts taken in March, 1942, in different areas of the Gezira gave a maximum infection of only 2·9% in Domains Sakel, at Taiyiba, to the north of the Scheme. In the experiment a total infection of 89% was recorded on 21st April, 1942, and the Table which follows gives the mean percentage infection for each selection (R) and its respective " spreader " (S) plants growing in the same row.

MEAN % LEAF CURL INFECTION IN PLOT 56N—SEASON 1941/42.

	Strains.	% L/C. 19th Mar., 1942.		% L/C. 31st Mar., 1942.		% L/C. 21st April 1942.	
		R	S	R	S	R	S
M.S.D.S.	87/39–3	90·4	62·7	96·3	84·1	99·3	92·9
	–5	55·4	79·6	72·3	92·7	85·4	95·6
	133/39–8	44·5	71·0	69·3	86·3	85·8	94·7
	–12	76·9	80·6	88·1	93·0	97·0	98·4
	–24	82·0	80·9	94·0	90·8	98·5	96·2
	–43	59·8	75·9	80·3	92·5	95·5	98·5
	–45	75·8	79·2	88·6	92·3	94·7	96·9
	–49	84·4	80·3	91·1	92·7	95·6	97·1
	–60	65·9	75·8	80·3	87·9	93·9	90·9
	142/39–25	78·8	76·4	86·4	86·2	93·2	94·3
	–29	87·4	74·8	96·9	91·9	100·0	98·4
	–45	59·5	76·7	77·9	88·7	95·4	94·0
	–50	74·4	82·2	87·6	93·8	93·4	97·7
P.S.S.700	N.T.97/40	2·2	74·5	3·7	83·2	25·0	94·9
	97/41	6·8	67·2	11·4	84·0	26·1	91·6
	F.S.4	6·9	75·0	10·8	87·5	32·4	92·2
	F.S.5	4·7	72·3	8·2	86·2	34·1	93·1
Unselected M.S.D.S. (Control) ...		76·7	84·3	88·7	91·8	95·5	96·3
Total Infection		60·0	76·1	71·4	89·2	82·5	95·2
Significance of Blocks		V. high	V. high	None	V. high	None	V. high
Significance of Strains		V. high	None	V. high	None	V. high	None
Standard Errors		14·0	14·7	11·4	9·3	8·96	6·09
Co-efficient of Variation		24·5	19·3	16·6	10·4	11·2	6·40
Sig. Diff. between Means (%) ...		13·9	None	11·3	None	8·86	None
Grand Total Infection (%) ...		68·3		80·5		89·0	

R=Selected Progeny. S=" Spreaders " separating each R plant in each row.

From the Table the following facts emerge :—(1) The selections of P.S.S.700 origin are all highly resistant. Seed from the free plants of N.T.97/40 will be bulked and carried forward. (2) With the exception of M.S.D.S. 87/39–5 and 133/39–8, both of which showed significant resistance, the M.S.D.S. selections went down badly to the disease, so obviously their freedom from it in the previous season was a chance effect brought about by the low incidence of the disease that year. Seed of the free plants of the two resistant lines will be bulked separately and carried forward. (3) M.S.D.S. (unselected) is not a fully susceptible strain and by selection it seems probable that resistant and fully susceptible strains can be obtained from it. Seed of diseased plants of the most susceptible strain will be bulked for use as " spreaders "and controls in subsequent experiments. (4) The highly significant block differences obtained for percentage infection in " spreaders " are suggestive. Such a significant block difference in " R " infection only occurs at the time of the first count and thereafter disappears entirely.

It has generally been considered that leaf curl follows no definite system of spread and is therefore sporadic in occurrence. In the experiment under review three significant facts are worth recording. Firstly, the presence of *Malvaviscus* sp.—an alternate host plant of leaf curl disease—in the residential garden to the east of the experiment; secondly, the main direction of the prevailing wind, north-east to south-west, during the early morning period in winter and early spring, and thirdly, the fact that there is a gradual diminution of infection from the north-east corner of the plot to the south-west as is seen in the following diagrams :—

% Leaf Curl Infection in "Spreader" Material as Affecting Position of Replicate Blocks.

	% *Leaf Curl at 19th March, 1942.*				% *Leaf Curl at 31st March, 1942.*				% *Leaf Curl at 21st April, 1942.*			
	Block 1	*Block 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*
	80·1	75·3	57·0	66·2	91·9	85·2	80·2	84·5	96·6	92·1	89·8	93·9
E.	*Block 5*	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*
	87·5	81·7	81·2	80·3	96·9	93·4	91·6	90·1	99·3	96·2	95·8	98·0
	North.				North.				North.			

% Leaf Curl Infection in "R" Plant as Affecting Position of Replicate Blocks.

	% *Leaf Curl at 19th March, 1942.*				% *Leaf Curl at 31st March, 1942.*				% *Leaf Curl at 21st April, 1942.*			
	Block 1	*B lock 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*
	60·0	58·4	49·1	49·8	71·0	68·2	67·4	65·5	82·3	81·5	81·1	81·5
E.	*Block 5*	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*
	72·9	69·4	62·3	59·5	80·8	77·4	69·2	72·8	83·8	85·6	83·4	81·4
	North.				North.				North.			

% Leaf Curl Infection in Both S and R Plants as Affecting Position of Replicate Blocks.

Total % L/C. at 19th Mar., 1942.				*Total % L/C. at 31st Mar., 1942.*				*Total % L/C. at 21st April, 1942.*			
Block 1	*Block 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*	*Block 1*	*Block 2*	*Block 3*	*Block 4*
70·3	66·9	53·1	58·1	81·7	76·8	73·9	75·1	89·6	86·8	85·5	87·8
Block 5	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*	*Block 5*	*Block 6*	*Block 7*	*Block 8*
80·5	75·7	72·0	70·1	89·2	85·7	80·7	81·7	91·9	90·9	89·8	89·9

It will be noted that Blocks 4 and 8 have in some cases a slightly higher infection than Blocks 3 and 7. This deviation from the general trend is explained by the theory that a small number of infected white fly could have come over from the infected material in the Observation Plots to the south-west of the experiment. In support of this theory the difference in infection between Blocks 4 and 3, south-west of the experiment, is greater than that between Blocks 8 and 7 which were slightly further away from the Observation Plots. It has been suggested that differences in block infection might be due to differences in block fertility, *i.e.*, that more vigorous plants are more liable to attack than less vigorous ones. Against this, however, is the work of Knight and Snow, at Shambat in 1931, which showed that intrinsic value of soil bore no relation to leaf curl incidence, although showing a high positive correlation with plant height measurements made on *Cajanus* in the same plot. In contradistinction, subsequent observations by Knight showed a strong positive correlation between

plant height and incidence of the disease, the heights being measured prior to the appearance of the disease. Crowther, in 1929, found a strong positive correlation between manuring and incidence.

It would seem that the spread of leaf curl in this experiment followed the direction of the prevailing wind and as the disease was first observed in Block 5, at the north-eastern end of the experimental site, it seems likely that it originated from the residential garden to the east of the experiment. Leaf curl made its first observed appearance on the Farm in the west belt of M.S.D.S. in the Breeding Plot on 14th October, 1941, and an old infection was first observed in the Observation Plot on 16th October, 1941. Both foci were to the south-west of the leaf curl experimental site. It was not observed in the leaf curl experiment until much later and it is likely therefore that the original infection would have come in from the south-west corner of the experiment and spread from there, unless spread was determined by the direction of the prevailing wind.

Next season a similar layout will be employed to test the following strains :—

1. L.C.R.12/41—Bulked seed of 15 free plants of N.T.97/40 grown this season.
2. M.S.D.S.1/41—Bulked seed of 4 free plants of M.S.D.S.133/39–8 grown this season.
3. M.S.D.S.17/41—Bulked seed of 5 free plants of M.S.D.S.87/39–5 grown this season.
4. N.T.97/40—Parent of L.C.R.12/41 (N.T.2/39 origin).
5. Fam.74/38—Grandparent of N.T.97/40 (N.T.2/39 origin).
6. Lecrem—Bulking of various resistant Sakel Types.
7. X1730—This and the other X1730 selections are highly resistant under Gezira conditions, but more susceptible than M.S.D.S. under Shambat conditions.

8. X1730A
9. X1730G
10. X1730H
11. X1730 J

} Subsequent selections from X1730 which behave like X1730.

12. N.T.2/38
13. N.T.2/39

} Resistant selections at both G.R.F. and Shambat of original Domains Sakel parentage.

14. N.T. 66/41
15. N.T.100/41
16. N.T.101/41
17. N.T.102/41

} Derivatives of commercial promise from P.S.S.700.

18. Resistant Domains Sakel—a bulk selection of 20 free plants from commercial Domains Sakel grown this season.
19. Domains Sakel—commercial type to be used as " Control " and for observation.

The east and west belts of the experiment will be sown for observation with X1530 and X1530A respectively, as both are selections for resistance under Gezira conditions.

Bulked seed of susceptible " spreader " plants grown this season will be used as " spreaders ". Weekly counts of infected plants will be plotted in order to confirm or disprove the theory of wind spread.

The Cotton Reference Plot.—Relatively pure seed stocks were obtained from the various Old and New World cottons grown this season and this work will be temporarily discontinued.

Testing various seed lots of M.S.D.S.—Stored stocks of M.S.D.S. seed dating back to the 1930/31 season and used to sow the "Observation Experiment" of the Plant Physiology Section, were grown in sixfold replicate this season with the object of determining whether genetic changes had occurred through natural selection and what characters had been most affected. It is rarely possible to go back ten or more years and compare final selections with original material. As cotton seed maintains its viability for long periods in the drier parts of the Sudan such a test is possible. A rather similar test was carried out by the writer on Sea Island (V.135) in St. Vincent, B.W.I., and is reported in the 1938/39 Progress Report of the Empire Cotton Growing Corporation. There, however, the original parent seed was obtained from a graft made by Harland in 1928 and compared with selections made 10 years later.

In the experiment under review low viability of the oldest lots of seed resulted in a single plant being obtained from the 1930/31 stock and only a few plants from the 1931/32 and 1932/33 stocks. No seed was available for the 1935/36 season. Selfed seed of these stocks was obtained this season and the experiment will be repeated. The results were of extreme interest and in spite of irregular stands coefficients of variation were of the order of 5% and under. Of the characters—weight of seed cotton per boll; weight of lint per boll; lint length; number of seeds per boll; weight of 100 seeds; lint index, and ginning outturn, only the first three showed a significant difference between seed stocks.

It is considered that the experiment is in too early a stage for conclusions to be drawn, especially as differential storage treatment of the seed probably affected the results. Now that selfed seed of each of the seed stocks is available from a single season's growth, storage effects will be eliminated and plot stands should be more uniform. Next season the seed stocks will be observed in a randomized block experiment with 10 replicates. The 5-plant plot will be used and observations on germination, plant height and bolling will be recorded for each individual plant, in addition to the already mentioned characters.

Cotton Varietal Trials.—The usual replicated Standard and subsidiary varietal tests were continued.

In the Standard Test, substrains of X1730 and N.T.2 were compared with Domains Sakel (control). Both the X1730 strains (X1730J and X1730A) gave significantly higher yields and showed an increase over Domains Sakel in lint per feddan of 26% and 25% respectively, but N.T.2 derivatives showed no significant difference. In the subsidiary Varietal Tests (X1730 series) five strains were tested—X1730A (control), X1730H, X1730J, X1730K and an X1730 7th backcross. The varietal variance between seed cotton yields did not reach the 5% level of significance.

Details of results of the N.T.2 series are given in the Table below :

SUBSIDIARY V.T. PLOT 36 G.R.F. 1941/42.

N.T.2. Section.

Table of Yields of Seed Cotton and Lint.

Strain.	*Seed Cotton. (K.p.f.)*	*G.O.T. (%)*	*Lint. (Rot.p.f.)*	*Lint as % of Domains Sakel.*	*Stand. (%)*	*Resown Holes. (%)*
GRADE "12"	5·57	31·6	554	108	84·3	41·3
H.T.2/38	5·33	31·9	535	104	77·5	57·1
H.E.T.2/7	5·65	29·9	532	103	89·7	31·7
N.T.2/39	5·29	31·7	528	103	87·8	27·9
Domains Sakel	5·49	29·7	515	100	90·9	22·1
BAR.2/1=(N.T.2/40) ...	5·51	28·2	489	95	92·6	34·7
BAR.2/4	4·92	28·3	439	85	89·3	40·0
BAR.2/5	4·49	30·3	430	83	79·6	54·8
S.E.	±·21	—	(±20·0)	(±3·88)		

At P = ·05 differences of 0·61 in second column are significant.
Domains Sakel has been appreciably favoured, while N.T.2/38 and B.A.R.2/5 in particular have been handicapped by both heavy re-sow and poor final stand.

Breeding and Testing of Dura—(*Sorghum spp.*) (S. H. Evelyn).

The Dura Type Collection.—The collection now numbers 335 types of which 307 were grown this season to obtain data mainly on yield and early maturity. "Buda," the sorghum root parasite, *Striga hermonthica*, seriously reduced yields in the Type Plot but the heavy attack showed up differences between types. Nine types from the Belgian Congo were observed under irrigation, but their performance was not very impressive.

The Dura Variety Trials at G.R.F.—Twelve varieties replicated eight times were tested in randomized blocks under rain and artificial irrigation in two separate parts of the same field. These included Feterita Maatuk, Feterita 1931 (Gondal) ; Shendi Feterita, Dwarf Feterita 5985, Dwarf Feterita 6603, Dwarf Hegari, Dwarf White Milo, Gassabi (T.105), Wad Fur, Abu Sabein, Ras El Girid and Feterita 1931 (G.R.F.) as control. The two tests were separated by belts of Dwarf Hegari to prevent water seepage from the Irrigated to the Rain Test. Germination was excellent and no varietal resow exceeded three per cent. thereby again showing that naphthalene treatment of stored seed had been very effective. Scarcity of rain at sowing time necessitated irrigating the "Rain" Test on 21st July, 1941, a day after sowing, but no further irrigation was given. The Irrigated Test received waterings on 21st July, 6th September, 26th September, and 7th October, 1941.

Striga damage was particularly heavy in both tests and the number of holes attacked per subplot was analysed and gave a highly significant varietal difference in the Irrigated Test in favour of Dwarf Hegari and Wad Fur. Treating the data from both tests together, the same significant result was obtained. Time of flowering was also analysed and gave a highly significant varietal difference in each test in favour of the dwarf varieties, especially Dwarf White Milo. Dwarf Hegari and Dwarf White Milo were significantly higher in grain yield than the others in both tests. Ras El Girid and Abu Sabein were significantly higher in "gassab" (stalks) yield. In the Irrigated

Test Dwarf Hegari and Dwarf White Milo significantly outyielded the control in gassab weight, but differences between these varieties were not significant in the Rain Test. The results given in the following Table should be regarded with caution in view of the heavy *striga* attack.

Yield of Grain and Gassab Expressed as a Percentage of the "Control."

Character.	*Feterita 1931 G.R.F. (Control).*	*Dwarf Hegari.*	*Dwarf White Milo.*
Grain Yield (Rain V.T.)	100	211	198
Grain Yield (Irrigated V.T.)	100	273	226
Gassab Yield (Rain V.T.)	100	97	100
Gassab Yield (Irrigated V.T.)	100	128	136
% holes attacked by *Striga* (Rain V.T.)	78	60	70
% holes attacked by *Striga* (Irrigated V.T.)	88	48	73

In general, experiments comparing Feterita 1931 (G.R.F.) with Dwarf Hegari have shown the latter to be about 15% superior in grain yield, but generally inferior in gassab yield although quality of gassab is considered as good. Demonstration plots of Dwarf Hegari will be grown commercially in the Gezira next season.

Striga incidence was particularly high this season and approximately 73% of the total number of holes in both experiments were attacked. The effects of rain and irrigation appeared to bear no relation to incidence as the difference in mean percentage number of holes attacked was only 2 per cent., although varieties showed up differently under the two treatments. In both the 1940/41 and 1941/42 seasons the Irrigation Tests have significantly outyielded the Rain Tests.

Self-compatibility in Sorghum spp.—In 1940 plants grown from selfed seed of the variety Kurgi appeared to give a lower grain yield than those in an adjacent row sown with natural seed. This season the yields from selfed and natural seed of the variety Gassabi were compared in randomized blocks and in spite of a severe *striga* attack "treatment" was significant at the 1% level in favour of selfed seed. A similar experiment containing 10 varieties widely differing in character was also severely attacked by *striga* and although in 63% of the material a yield difference in favour of selfed seed was obtained, this difference was not significant. The results, although scanty, suggest that self-fertilization does not impair the yielding capacity of the Sorghum species under trial.

Smut Resistance Trials.—The Plant Pathology Section kindly tested a number of dura types for susceptibility or resistance to common smut, *Sphacelotheca sorghi*. Seed of 259 types was treated with common smut spores and sown out. Four of the types failed to germinate; 169 types developed the disease in varying degree; 60 types which headed normally did not develop the disease and the remaining 26 types could not be tested as they failed to form heads within the period of the experiment. Next season the free types

will be re-tested along with the 26 types that failed to head. Some 80 new types, of which seed is now available, will also be tested.

Miscellaneous Dura Trials at Out-stations.

Abdel Magid (*Blue Nile Province*).—The local Feterita strain was tested against other Feteritas and Dwarf Hegari and Dwarf White Milo. Apparently, in spite of the earlier maturity of the dwarf types, their harvest was delayed until all varieties in the test had matured and the early types were consequently exposed to greater bird damage. Varietal differences in grain yield were just barely significant at the 5% level, although in gassab yield such differences were highly significant. In grain and gassab yield no significant superiority was shown by the control over Dwarf Hegari. The test will be repeated.

Sweet sorghum varieties obtained from South Africa were tested by the Inspector of Agriculture, Abdel Magid, this season. All five varieties produced excellent and very palatable gassab. Observation plots of these will be grown next season at G.R.F. and sucrose contents determined. Their introduction was suggested as a means of improving silage value.

Nuba Mts. (*Kordofan Province*).—Seventy-nine types, mainly local, were re-tested in unreplicated plots at Dilling and Talodi, and tried out for the first time at Kadugli.

At Dilling the types Kalur, Wad Aker (Kadugli), Kokla, Huria White, Feterita (Kadugli), Kurmuka, Nagad Mur and Tingra gave the best results with a mean grain yield over two seasons of between 1,600 and 2,000 rotls per feddan. The maturation period of these varieties varied from 96 to 117 days.

At Kadugli, further south, the types Bangitbar, Darfuri Aghbush, Darfuri Watani, and Culum Ahmar were the best on the one season's results, though yields were in general lower than at Dilling, and maturation periods later. The grain yield of these varieties ranged from 1,050 to 1,275 rotls per feddan and their maturation periods from 122 to 146 days.

At Talodi, still further south, grain yields were generally lower and maturation periods slightly later than at Kadugli. Here, the types Jangi, Kadeika, Toto, Messeria, Mendo, Safari and Kulum gave the best mean grain yield for the two seasons of trial. It varied from 1,000 to 1,200 rotls per feddan and maturation periods for the same types ranged from 104 to 144 days. It is considered that a further season's trial will provide sufficient data to permit of selection of the best types for inclusion in replicated tests in 1943. Ten types, which after two seasons' trial were considered obviously unsuited to the environment, have been replaced by thirteen other promising types. Early maturity is of course receiving marked attention.

Maridi and Luluba Hills (*Equatoria Province*).—This season, the early maturing variety Dwarf Hegari was tried out at Maridi and in

the Luluba Hills. Notwithstanding certain disadvantages, the natives were much impressed with its earliness, yield and dwarfness. Dwarfness is an economic advantage in this area where all dura types are exceedingly tall and at maturity cannot be harvested by small children. Unfortunately, at Maridi, early maturing types such as Dwarf Hegari, if sown at the usual time, ripen under very humid conditions and the heads, particularly if they are compact, are attacked by mould fungi. It is interesting to record that the dura types in this area are all very tall, very late maturing and with very open heads. Another disadvantage shown by Dwarf Hegari was its susceptibility to damage by store-pests. The natives in this area claim that small, hard grain is not so liable to damage in storage as large, soft grain and during a recent tour in Equatoria it was observed that almost all local types produced small, hard grain. Seed of these same types, however, has been received at G.R.F. in a very damaged condition and in storage has not shown any marked resistance to storage pests.

In spite of these disadvantages, requests for Dwarf Hegari seed in commercial quantities have been received from both stations. The varieties Dwarf White Milo, Dwarf Yellow Milo and Feterita 1931 were also tried out in these areas, and although the two former types were not as well liked as Dwarf Hegari, they nevertheless found popularity with the natives, who have asked for seed for commercial trial. Feterita 1931 was not a success.

Next season, in addition to a replicated test at Maridi of eight promising varieties, forty types of potential merit will be observed in unreplicated lines at Amadi, Maridi, Luluba Hills and Torit, through the kind co-operation of the District Commissioners and the Inspectors of Agriculture.

Future Out-station Work.—Next season, in addition to the variety tests which will be conducted on a rain area to the north of the Farm, rain trials will also be carried out in the Gezira at Gondal and Managil and across the river at Rufaa. Replicated variety tests will be conducted at the Pumping Stations—Ed Dueim, Hashaba, Umm Gerr and Fatisa—on the White Nile, similar to the test designed for Abdel Magid. An unreplicated test of 30 types will be carried out at Tokar under flood irrigation and the programme of work for the Nuba Mountains and Equatoria Province has already been referred to. It is hoped also to conduct trials at Shendi and Nuri in the Northern Province.

SHAMBAT STATION.

(R. L. KNIGHT).

Introduction.

This season has seen the virtual completion of the work of synthesizing Blackarm-resistant Sakel strains from Uganda B.31 × Sakel crosses and it has been possible to give increasing attention to other hybrids. Considerable preliminary work on breeding Blackarm-resistant

American Upland types has been done and a start has been made towards transferring the Blackarm immunity of *G. Sanguineum* (*G. arboreum* v. *neglectum* f. *bengalensis* H. & G.) to New World types. The work of transferring the *arboreum* gene R (reddish flowers and leaves) to Blackarm-resistant Sakels has been completed. Breeding for jassid-resistance in both Sakels and Americans continues.

Meteorology.

The season was characterized by excessively high summer temperatures and an abnormally cold winter. The high temperatures handicapped cotton sown at the normal time and the low winter temperatures made the raising of an out-of-season crop exceptionally difficult. Rainfall was about normal in total quantity, but very abnormal in distribution, more than half the year's precipitation falling on one day.

Agriculture.

Owing to the war no sulphate of ammonia was available for the cotton crop, cotton seed cake was used as a substitute and appeared to be efficient, though no comparative tests were made. For winter sowings, however, cotton cake was too slow-acting and the lack of sulphate of ammonia was a definite handicap.

Genetics and Breeding.

Transference of Blackarm Resistance Factors $\mathbf{B_1}$ *and* $\mathbf{B_2}$ *from Uganda B.31 to Sakel.*

(*a*) *Breeding.*—The 9th Sakel backcross of N.T.2 and X1730 type was grown this year, but seed of 9th backcross N.T.66 type was stored pending further testing of N.T.66 itself, as this strain has not fulfilled its earlier promise.

Resistant plants in these 9th backcross hybrids were selfed and F_2 families of the following composition* were grown in 1942–43 winter :

(1) $\{[(B.31 \times X1530B) \times N.T.2/36^2] \times N.T.2/37\} \times N.T.2/38^6$
(2) $(\{[(B.31 \times X1530B) \times X1530A] \times X1530E^2\} \times X1730G^2) \times X1730H^4$

From these 9th backcross F_2 families it has been possible to produce selfbred seed which, after the elimination of heterozygotes, will be used for sowing bulk propagation plots in 1942–43 season of N.T.2/38 and X1730H type homozygous for $\mathbf{B_1}$ and for $\mathbf{B_2}$.

To bring the N.T.2 backcrossing up to date one $\mathbf{B_1b_1}$ plant and one $\mathbf{B_2b_2}$ plant in (1) were each crossed with N.T.2/39 and in the progeny of this cross, sown out-of-season, a $\mathbf{B_1}$ and a $\mathbf{B_2}$ plant were selected and further crossed to N.T.2/39 making the 11th Sakel backcrosses.

* As in previous reports, superscripts denote the number of times each strain has been used as a parent. The usual practice of writing the female parent first has not been followed in this report. The system of notation at Shambat is to write the donor parent first and successive backcross parents after it.

These progenies should contain approximately 75·0% N.T.2/39 " blood," 24·6% N.T.2/38, 0·3% earlier N.T.2 types and a negligible quantity of Uganda B.31 and X1530B.

(*b*) *Bulk propagation.*—Bulk propagation plots of the following types have been grown this year :—

(i) $\mathbf{B_2B_2}$N.T.2.—5½ acres of F_3 material from the 7th Sakel backcross were grown. The plot was sown at wide spacing with only one seed per hole ; it was further handicapped by suffering from a heavy jassid attack. A final yield of just over one ton of seed was produced and this will be available for bulk propagation and testing in the Gezira in 1942–43. Ginning outturn was normal.

(ii) 4½ acres in the Gash delta were sown with N.T.2 homozygous for $\mathbf{B_2}$. This variety is of 5th Sakel backcross origin and the plot was intended partly as an " inspection " area and partly to provide seed for further propagation if tests of this type in the Gezira this season warrant it. Lint tests on replicated samples of this type have shown it to be fully equal to its N.T.2 parent in all respects but its ginning outturn, which proved to be rather low.

(iii) In addition, smaller propagation plots of the following 7th backcross types were grown at Shambat : $\mathbf{B_1B_1}$N.T.2 (¼ acre), $\mathbf{B_1B_1B_2B_2}$N.T.2 (1½ acres), $\mathbf{B_2B_2}$X1730 (1¾ acres), $\mathbf{B_1B_1}$X1730 (⅛ acre).

(*c*) *Testing.*—Seed of the following types was supplied to the Senior Plant Breeder at Wad Medani for testing this season and details of the results of these tests will be found elsewhere :—

Variety.	*Type.*
BAR 2/1 ..	$\mathbf{B_2B_2}$N.T.2 from 5th backcross.
BAR 2/4 ..	$\mathbf{B_1B_1B_2B_2}$N.T.2 from 5th backcross.
BAR 2/5 ..	$\mathbf{B_1B_1}$N.T.2 from 5th backcross.
" Grade 12 " ..	$\mathbf{b_1b_1b_2b_2}$N.T.2 from 5th backcross.
HET 2/7 ..	from $\mathbf{B_2b_2}$N.T.2 plants in 7th backcross.
HET 4/1 ..	from $\mathbf{B_2b_2}$X1730 plants in 7th backcross.

Transference of $\mathbf{B_2B_3}$ *from G. punctatum* to Sakel.

(*a*) *Genetical.*—Two linked factors with a 32% recombination of the *punctatum* selection FS.2. One of these proved to be $\mathbf{B_2}$; the other factor, $\mathbf{B_3}$, is semi-dominant giving " 8·1 " resistance when heterozygous and grade " 5·1 "–" 6·1 " when homozygous. This latter factor is likely to be of great value since the combinations $\mathbf{B_3}+\mathbf{B_2}$ and $\mathbf{B_3}+\mathbf{B_1}$ both confer greater resistance on Sakel than $\mathbf{B_1}+\mathbf{B_2}$.

(*b*) *Breeding.*—5th Sakel backcrosses were grown this season and crossed with their respective parents. These 6th Sakel backcrosses

were sown 1941–42 winter and from them 7th backcross seed has been produced. These winter-sown 6th backcrosses had the following composition :—

(1) $\{[(FS.2 \times X1530A) \times X1730F] \times X1730G\} \times N.T.2/38^4$
(2) $(\{[(FS.2 \times X1530A) \times X1730F] \times X1730G\} \times N.T.2/38^3) \times N.T.2/39$
(3) $\{[(FS.2 \times X1530A) \times X1730F] \times X1730G\} \times X1730H^4$

Flagging Blackarm-resistant Sakel strains with the arboreum gene **R**.

(*a*) *Breeding.*—The object of this work is to make blackarm-resistant strains easy to identify and keep pure. The gene **R** confers reddish flowers and leaves on Sakel so that admixture will at once be visible. 9th and 10th backcrosses on the N.T.2 side and 8th and 9th on the X1730 side were grown in season and out of season this year, the winter-sown families being of the following make-up :—

(1) $(\{[(RU.4 \times Sakel) \times X1530E] \times X1530A\} \times X1730F) \times N.T.2/38^7$
(2) $[(\{[(RU.4 \times Sakel) \times X1530E] \times X1530A\} \times X1730F) \times N.T.2/38^6] \times N.T.2/39$
(3) $(\{[(\{[(RU.4 \times Sakel) \times X1530E] \times X1530A\} \times X1730F) \times X1730G] \times X1730H\} \times X1730A) \times X1730H^3$

(*b*) *Bulk Propagation.*—An isolated $\frac{1}{4}$-acre bulk propagation plot of red resistant X1730 (*i.e.* **RR** $\mathbf{B_2B_2}$) of 7th Sakel backcross origin was grown in 1941–42 winter to produce seed for testing and small-scale propagation in the Gezira in 1942–43. A $\frac{1}{4}$-acre plot of red susceptible X1730 of similar origin was also grown to provide seed for comparative tests. In addition, small plots were grown of red resistant N.T.2 and of red susceptible N.T.2, both of 8th Sakel backcross origin.

Jassid Resistance : Transference of Hairiness from Tanguis to Sakel and American Types.

2nd backcrosses of the N.T.2 and X1730 side were grown in season, 3rd backcrosses were grown in 1941–42 winter and seed of 4th backcross composition has been produced for the 1942–43 crop.

On the American Upland side Tanguis hairiness is being transferred to Uganda SP.84 R and Deltapine, and first American backcrosses were grown in 1941–42 winter from which 2nd backcross seed has been made for growing next season.

Production of Blackarm-resistant strains of American Upland for the Southern Sudan.

(*a*) *Uganda SP.84 R.*

(i) *Genetical.*—300 seeds of Uganda SP.84 R were imported through the kindness of Mr. H. R. Hosking of the Uganda Department of Agriculture. 200 of these were sown and from them 137 plants were raised and sprayed with Blackarm suspension. 79 Blackarm-resistant plants were present, the remaining 58 plants showing full (American)

susceptibility. There were no intermediate types and the resistance of the resistant plants was exactly similar to that shown by controls of N.T.61—a Pump Scheme derivative to which $\mathbf{B_2}$ has been transferred.

Forty-seven resistant plants were selfed and grown in progeny rows in 1941–42 winter ; of these 14 proved to be homozygous for resistance and 33 were heterozygous. Thirty of these 33 families were examined in detail and they showed a total of 2,358 resistant to 692 fully susceptible plants against an expectation on a 3 : 1 basis of $2{,}287\frac{1}{2} : 762\frac{1}{2}$. The total X for these figures (obtained by adding together the individual X^2 figure for each family) is 29·00, giving P. approximately 0·5 and proving that the figures obtained do not differ significantly from a monohybrid 3 : 1 ratio. Clearly the resistance of Uganda SP.84 R is due to a single factor, and since the degree of resistance is identical with that conferred by $\mathbf{B_2}$ (the usual resistance factor in American types), there can be little doubt that this gene is $\mathbf{B_2}$.

(ii) *Selection.*—Seed from the 14 progeny rows of Uganda SP.84 R, mentioned above as being homozygous for $\mathbf{B_2}$, will be used for sowing a $3\frac{1}{4}$-acre propagation area next season under the strain reference number BAR 7/1. In addition, all fully susceptible plants in Uganda SP.84 R were selected for bulk selfing and this seed will be used for sowing a 1-acre propagation area of the susceptible component of SP.84 R under the reference number SUS.7/2. It is intended to ascertain the value of $\mathbf{B_2}$ in Equatoria by comparing BAR 7/1 with SUS 7/2 in replicated experiments.

(iii) *Hybridization.*—F_1 plants of $\mathbf{B_3B_3}$ *punctatum* × SUS 7/2 were raised in 1941–42 winter and were found to display grade " 8·1 " resistance. First backcross seed has been made from these and this will be grown next season. This is the first step towards transferring $\mathbf{B_3}$ to SP.84 R.

(*b*) *Deltapine.*

(i) *Selection.*—This variety suffered very severely from jassids at Shambat this season, the attack being such that leaves were prematurely hardened so that Blackarm-resistance effects were obscured. Nevertheless, though for the most part fully susceptible, this strain does contain a few plants which appear to be resistant. Several of these have been selfed in an attempt to obtain a resistant substrain by selection. Test-crosses have been made to determine the resistance factor or factors involved.

(ii) *Hybridization.*—Crosses between N.T.61 and Deltapine were made as a first step towards transferring $\mathbf{B_2}$ from the former to the latter. The F_1 family was grown in 1941–42 winter and 1st backcross seed has been made for sowing next season. In addition, an F_1 of $\mathbf{B_3B_3}$ *punctatum* × Deltapine was grown as a winter crop and 1st backcross seed has also been made from this with the object of adding $\mathbf{B_3}$ to Deltapine.

(*c*) *511 D.*

B_3 is being added to this strain from *punctatum* ; the type already contains B_2.

(*d*) *XA129.*

This Pump Scheme derivative, like its parent type, is fully susceptible to Blackarm. B_3 is being added from *punctatum* and B_2 from N.T.61. First backcrosses were made in 1941–42 winter.

Transference of Blackarm immunity from G. Sanguineum (n=13) to New World (n=26) types.

26 F_1 plants were raised as a result of straight crossing between N.T.2/38♂ and *G. Sanguineum*♀ (*G. arboreum* v. *neglectum* f. *bengalensis* H. & G.). In addition, with the aid of colchicine, a " Sanguineum " plant was produced which, though completely self-sterile, hybridizes freely with New World types. This plant has been given the number FS.26. A number of F_1 seeds of N.T.2♂ × FS.26♀, XA129♂ × FS.26♀, and Deltapine♂ × FS.26♀ were produced, a few of these were sown in 1941–42 winter and three plants of XA129 × FS.26 composition were raised for backcrossing to XA129.

The 26 F_1 plants of *Sanguineum* × N.T.2 composition were regularly pollinated with N.T.2 pollen and set 23 natural seeds and 69 seeds of 1st Sakel backcross composition. The 23 natural seeds are possibly also of Sakel backcross type since the F_1 plants were surrounded by Sakel.

Classification of various American Upland strains on Blackarm-resistance.

20 American types were sprayed with Blackarm suspension and their reaction examined. The varieties were interspersed with B_2 controls and it was found that where resistant plants occurred the degree of resistance was exactly similar to that associated with B_2. The varieties have, accordingly, been listed below under the headings " resistant " (*i.e.*, similar to B_2) and " fully susceptible " (*i.e.*, grade " 10 " the natural full susceptibility in American Upland).

Variety.	*Resistant Plants.*	*Fully Susceptible Plants.*
N.T.91/40	22	—
N.T.43/37	14	9
N.T.68/40	7	17
N.T.83/40	11	12
511 D	113	13
511 E	23	—
S.P.84	15	—
S.P.84.R	79	58
S.P.102	23	— } Three successive importations made respectively in 1937, 1938 and 1940.
S.P.102	22	— }
S.P.102	23	— }
B.181	22	—
Deltapine	Mostly fully susceptible but grading affected by severe jassid attack.	
X.A.129	—	68
N.T.61/38	24	—
N.T.96/40	7	37
N.T.15/40	16	7
N.T.78/39	6	16
Wilds No. 11	—	34
Uganda S.G.29	—	41

A more detailed investigation of the question of Blackarm resistance in American types will be carried out by the writer next season in the Southern Sudan and in Uganda.

Leaf-Curl resistance.

Last season it was shown that though X1730A, X1730F, X1730G and X1730H all show marked leaf curl resistance in the Gezira, this resistance does not obtain under Shambat conditions where these strains were shown to be statistically more susceptible than Sakel. This raised the question whether these substrains of X1730 have lost the leaf curl resistance associated with the original X1730 or whether X1730 was ever, in fact, resistant under Shambat conditions (its resistance under Gezira conditions is an established fact which has never been in question). Accordingly X1730 and X1730H were tested against each other—there being 12 replicates of each. Leaf curl was not severe at Shambat this season but a sufficient percentage infection was obtained to demonstrate that neither strain differed appreciably from the other. X1730 showed an average infection of 15·7% against 15·9% for X1730H.

Bamia (*Hibiscus esculentus*).

3,270 rotls of pure Momtaza bamia seed were supplied during 1941 but demand again greatly exceeded supply. Propagation will, in future, be carried out by the Department of Agriculture and Forests, nucleus seed being supplied from small propagation areas at Shambat.

Early-sown bamia was a failure at Shambat this season. Momtaza bamia suffered also, but much less severely than the local crop. The following yields from a May-sown variety test, sown on the School of Agriculture farm, through the courtesy of the Principal, illustrate this. The test was a comparison between two substrains of Momtaza and two varieties of local bamia—a coarse low quality type (Beladi A) and a better quality type (Beladi B). The layout was 8 randomized blocks.

Yield in pounds of Green Pods per Acre.

Momtaza 12	1,727·0
Momtaza 12A	1,535·6
Beladi A...	97·2
Beladi B...	46·6

The difference between the two types of Momtaza is not statistically significant, that between Beladi A and Beladi B is nearly significant, and all other differences are highly significant.

A repeat of this experiment (re-randomized) sown in August gave the following results :—

Yield in pounds Green Pods per Acre.

Momtaza 12	5,892·0
Momtaza 12A	5,548·0
Beladi A...	2,536·6
Beladi B...	1,940·0

Again there was no significant difference between the yields of the two Momtaza types nor between the yields of the two Beladi types but all other differences were significant.

Momtaza bamia has become so popular with cultivators in Shambat district that it is doubtful whether any " beladi " bamia will be grown next season.

Summary and Conclusions.

N.T.2 and X1730 strains of 7th backcross composition containing Blackarm resistance factors $\mathbf{B_1}$ and $\mathbf{B_2}$ were propagated in bulk, 9th backcrosses were grown and from them seed has been produced for next season's propagation plots. This completes the breeding programme for Blackarm-resistant Sakels from American Upland (Uganda B.31) crosses.

Transference of the linked Blackarm-resistance factors $\mathbf{B_2B_3}$ from *G. punctatum* to N.T. 2 and X1730 strains was carried to the 6th backcross stage. $\mathbf{B_3}$ is semi-dominant, but in the homozygous state is the strongest resistance factor so far discovered.

7th backcross propagation plots of X1730 containing the *arboreum* gene **R** (reddish flowers and leaves), obtained from Harland's RU.4, with and without $\mathbf{B_2}$, were grown. On the N.T.2 side similar propagation plots of 8th Sakel backcross origin were grown. This virtually completes the work of flagging Blackarm-resistant Sakel with the gene **R**.

The transference of the Tanguis hairiness gene **H** (for jassid-resistance) to N.T.2 and X1730 strains was carried to the 3rd backcross stage.

20 American Upland strains were classified on Blackarm-resistance and the Uganda variety SP.84 R was sorted into its Blackarm-resistant and susceptible components, and seed homozygous for $\mathbf{B_2}$ was produced for bulk propagation. A start was made towards transferring $\mathbf{B_3}$ to SP.84 R, 511 D, Deltapine and XA129. The objective here is the synthesis of Blackarm-resistant American Upland types for Equatoria.

In two variety tests Momtaza bamia (*H. esculentus*) again showed its marked superiority over the native varieties and this strain is becoming increasingly popular with the cultivators.

PROGRAMME OF EXPERIMENTS, SEASON 1942-43.

1. The breeding of Blackarm-resistant strains of American and Sakel cotton to continue.

2. Continue the transference of Blackarm-resistance from *G. arboreum* to Sakel.

3. Hybridization for jassid-resistance to continue.

4. Examination of a number of wild cottons with a view to determining their Blackarm-resistance and other useful characters.

5. Preliminary work on inheritance of ginning outturn. This question is of outstanding importance in the Southern Sudan because of (1) the cost of transport, and (2) the Government's practice of buying seed cotton.

KADUGLI STATION.

(R. R. ANSON).

Introduction.

The season was the second abnormally dry one in succession, not so much in actual rainfall as from bad and patchy distribution. In instances where early stands were obtained normal yields resulted, but later plantings gave poor yields and poor quality lint containing a large proportion of immature fibre, resulting in a concomitantly low ginning outturn. At Talodi conditions were better and results obtained may be taken to represent more closely normal yields appertaining to the Nuba Mountains as a whole.

Meteorology.

On the Kadugli station the total rainfall for the season was 755·7 mm., just under the average. The usual planting rains in June and July were insufficient and the bulk of the planting had to be done in late July and early August. With the exception of a moderately heavy shower which fell during the second week in November (this, being both late and too widely spaced from other showers, did more harm than good) rains ceased on 17th October, 1941. However, outlying areas from Kadugli did not all share the same fate and some had a good and consistent distribution throughout. These areas are producing excellent crops.

Agriculture.

Three systems of rotation have been practised at the station. This has not been done with the idea of ascertaining which is the best system, but with the object of obtaining as much isolation as possible with the greatest economy in areas cultivated.

On the Main Farm, cotton standard varietal tests were grown in a three-course rotation with dura (*Sorghum*) and soya bean (*Glycine hispida*). Nucleus Roguing Plots were grown in rotation with velvet bean (*Mucuna nivea*) ploughed in.

On the New Kamina Farm area, a four-course rotation was adopted ; this included cotton, dura, velvet bean and Ads (*Cajanus indicus*). Moderately substantial " tagnets " (ridges) were thrown up between hoshas, in order to discourage soil erosion and surface wash.

Breeding, Propagation and Testing.

Fifty-two families were sown in the American Breeding Plots. These included substrains from Uganda B/31/10/12/11, Pedigree Dixie, Lone Star, N.T.71/39, P.S.Stn., Durango, 511 C, Acala,Uganda SP.20, Uganda SP.84, N.T.43/37, N.T.15/39 and Wild's No. 1.

Owing to insufficient rain, seed was sown rather late (16th July, 1941). There was a considerable spell of dry weather after sowing; this, combined with severe insect attack (mainly millipedes), gave rise to poor germination. Repeated re-sowings failed to improve matters much. Finally, owing to the severity of the millipede attack it was decided to plant out sister plants in bottomless tin cylinders placed on an area treated with cotton seed tar. This operation was quite successful and seedlings were transplanted into their permanent sites when suitable weather occurred.

Trinidad Hybrids and Hybrid American.—These hybrids being on slightly better soil than P.Ls, gave better results. They included substrains of (U.4 × Cambodia) × U.4, (Cambodia × Jamaica Xerophytic) × U.4, (U.4 × Cambodia) × Jamaica Xerophytic, (U.4 × Over The Top), (57 × Over The Top), and (513 × B.31) × 513. Growth was fairly satisfactory, but owing to general drought, closed down fairly early. Several of the most promising families are being bulked for further tests.

Blackarm (*B. malvacearum*).—Some 15 plants of each strain grown in the Breeding Plots were thrice sprayed with *B. malvacearum* suspension in water and records made of their comparative resistance. This was done in co-operation with the Plant Breeder, Shambat, who was able to confirm that the $\mathbf{B_2}$ factor is present in a number of families, some of which are homozygous for it. It was arranged to render some of the more promising "mixed" families homozygous for $\mathbf{B_2}$ and this will be done either at Shambat or Kadugli in the coming season.

Line Tests.—In the Line Tests only 3 out of 18 strains tested failed to give an increase in yield of seed cotton over the control, but controls throughout gave fairly erratic yields which may have been due to late sowing and sporadic effect of *B. malvacearum* infection. Owing to severe termite attack the strains tested and their respective controls (Pump Scheme Strain) were not equalized until just prior to picking.

Several strains show promise, especially Nos. N.T.88, N.T.94, N.T.205, N.T.201, N.T.210.

In the 100-boll samples the most outstanding for actual weight of lint were N.T.88 and N.T.210 followed by N.T.205. These and others will be bulked for further trial.

Selfing Propagation Plots.—In instances where sister plants of strains tested in Line Tests were not being grown in the Breeding Plots, Selfing Propagation Plots were planted with selfbred seed on a piece of good land adjacent to the new well so that they could, if necessary, be irrigated. These included N.T.203 and N.T.204 from B.31/10/12/11, N.T.201 and 205 from S.P. 20, N.T.206 from S.P.84, N.T. 202 from Durango, N.T.207 and N.T.208 from (513 × B31) × 513, N.T.209 (U.4 × Cambodia) × U.4 and N.T.210 from (U.4 × Jamaica

Xerophytic) × U.4. Millepede attack was very severe and consequently germination was poor, but the advantages gained by irrigation resulted in an ample supply of seed from each row for future tests.

Bulk Propagation Plot.—"Investigation Area" Damgamad; Deltapine seed from N.R.P.(2) 1940/41 season. Area 67 feddans of moderately uniform black cotton soil. Planting of the whole area was completed with the first planting rains which fell towards the end of June and early July. Growing conditions were good until mid-August when there was a dry spell lasting for nearly three weeks. This caused a certain amount of shedding, but subsoil moisture was sufficient to keep plants from wilting until good well spaced rains fell in September.

The yield 9·6 (small) kantars* per feddan is the highest average reached at Damgamad and represents an average increase of 3 kantars of seed cotton per feddan. The average G.O.T. for all pickings was 38·8%. This shows a 9·6% increase over any cotton previously grown at Damgamad. The actual yield of lint per feddan was 3·62 kantars as against 1·93 kantars the highest previously obtained. This shows an increase of 87·5% which is very satisfactory. In quality the lint is harsh, wiry and has a slight colour, but if it is saleable it should be more profitable even at a price distinctly lower than P.S. Strain. These significant differences of yield and G.O.T. have been borne out in the standard varietal tests both at Kadugli and Talodi, but not to quite the same extent.

DELTAPINE, 1941–42

DAMGAMAD INVESTIGATION AREA, TALODI.

Picking.	*Picking Weight of Seed Cotton. Rotls.*	*Store Weight of Seed Cotton (Unclean). Rotls.*	*Ginning Weight of Seed Cotton (Clean). Rotls.*	*Total Weight of Lint. Rotls.*	*G.O.T.* %	*Total Weight of Seed. Rotls.*
I	21,228·0	20,779·5	20,256·5	7,918·0	39·1	11,937·5
II	14,019·0	13,660·5	13,477·0	5,268·0	39·0	7,874·0
III	10,464·0	10,444·0	10,311·4	3,999·7	38·8	5,995·0
IV	9,761·0	9,781·0	9,737·5	3,763·3	38·6	5,835·4
V	4,535·0	4,539·0	4,519·0	1,710·0	37·8	2,759·5
VI	2,980·0	2,984·0	2,973·5	1,105·5	37·1	1,829·9
VII and VIII	1,251·0	1,251·0	1,246·0	488·0	39·1	737·0
TOTAL	64,238·0	63,439·0	62,520·9	24,252·5	38·8 Average	36,968·3

Increase Area (*Berdab*) *Fellata Area.*—Sown with N.T.43/37 (U.4 × Gambia 14) × U.4, towards the end of July which is considered rather late. Good and well spaced rain fell after sowing. All sowing operations were supervised by a Ziraa Agriculturalist (kindly loaned by the Senior Inspector of Agriculture), who lived on the spot until sowing had been completed. The actual area sown was 1,063 feddans, out of which 105 were planted with special seed (as a nucleus to form a second wave). The natives were very satisfied with this cotton. They claim that N.T.43 is giving double the yield of P.S. Strain but

* 1 small kantar = 100 rotls. or 99 lb.

this may be attributed to its greater resistance to *B. malvacearum* in a season when, owing to late plantings, *B. malvacearum* did much more damage to the susceptible variety, P.S. Strain, than it probably would have done if it had been planted earlier as in seasons of normal rainfall distribution. Notwithstanding its marked success this season, it is not intended to bulk up N.T.43 for the Nuba Mountains because it is a rather late maturer and consequently not suitable for many areas. It has, however, been decided to store a considerable quantity of pure seed in case it should be found useful in districts with a heavier rainfall extending over a longer period. Comparisons for ginning outturn with P.S. Strain (Grade I) gave the following results :—N.T.43/37—32·0% ; P.S. Strain—30·1%.

Varietal Trials.—Three varietal trials, between them containing eight different strains, were grown at Kadugli and Talodi. The stands, both in the Preliminary Varietal Test and in the Main Standard Test, were good, but both were late planted and suffered very severely from drought which reduced the quality of the lint to a great extent and caused a general fall in the G.O.T. of each variety. Notwithstanding this, however, it will be seen that in order of yield the sequence is very similar to that of the last season.

N.T.43/37, being later than other varieties, was more severely affected by late planting and did not therefore catch up before the season closed down. At Talodi, where the rainfall was more evenly distributed and seed was planted earlier, N.T.43/37 took up its usual sequence in order of yield.

The final yields of all Tests are given in the following Tables :—

Standard Varietal Test, Kadugli.

Strain.	Seed Cotton.		G.O.T. %	Lint.	
	Kts. per feddan.	% Control.		Rotls per feddan.	% Control.
Deltapine (imported from U.S.A.)	1·57	127	34·8	173·0	165
N.T.68/39 (a Columbia 44 derivative)	1·40	113	28·2	125·0	119
N.T.58/39 (outcross from Punjab early)	1·33	107	27·5	116·0	110
P.S.Stn. (local)	1·24	100	26·9	105·0	100
N.T.43/37 (Trinidad Hybrid)	1·06	85	27·3	92·0	88
S.E.	±0·06			±5·58	±5·31

The S.E. was obtained from analysis of seed cotton yields.

At P = 0·05 differences of 14·5 in the third column are significant.

Standard Varietal Test, Talodi.

Strain.	Seed Cotton.		G.O.T. %	Lint.	
	Kts. per feddan.	% Control.		Rotls per feddan.	% Control.
Deltapine	4·27	109	39·0	525	142
N.T.58/39...	3·85	99	32·2	391	105
N.T.43/37...	3·97	102	30·9	387	104
N.T.68/39...	3·78	97	31·5	375	101
P.S.Stn.	3·90	100	30·2	371	100
S.E.	±0·13			±13·5	±3·64

Varietal Variance between seed cotton yields did not reach the 5% level of significance.

PRELIMINARY VARIETAL TEST, KADUGLI.

Strain.	Seed Cotton.		G.O.T. %	Lint.	
	Kts. per feddan.	% Control.		Rotls per feddan.	% Control.
N.T.15/40 (Trinidad Hybrid)	1·56	121	30·4	148·1	132
N.T.96/40 (57 × Over The Top)	1·50	116	31·0	146·2	130
N.T.58/39...	1·55	120	29·2	143·7	128
P.S.Stn.	1·29	100	27·9	112·4	100
N.T.75/39 (from P.S.Stn.)	1·23	95	26·5	102·0	91
S.E.	±0·045			±4·17	±3·71

The S.E. was obtained from analysis of seed cotton yields.
At P = 0·05 differences of 18·06 in the third column are significant.

CONCLUSIONS.

Deltapine has again been the most outstanding of all strains tested, especially at Damgamad where from 67 feddans it produced 97¼ bales of lint as against 53 bales, the highest yield yet produced from the same area.

The lint is somewhat wiry, harsh and coloured but in length it has improved from 1″–1 1/16″ to 1 1/16″–1⅛″ (from hand and combing tests).

Brokers valued samples (second pickings from Standard Varietal Tests at Kadugli and Talodi) at 9·25d. and 9·50d. respectively; roughly 50 points below P.S. Strain grown on adjacent plots.

N.T.43/37 yielded very well and is averaging 5 small kantars over an area of 1,000 feddans.

Both of the above mentioned cottons have rather a high colour which brokers predict is likely to be detrimental for selling purposes.

N.T.68/38 has been well reported on by Messrs. Wolstenholme and Holland, and was valued at 37 points on P.S. Strain, but not being resistant to *B. malvacearum* this strain is not likely to be a great success in the Nuba Mountains.

N.T.58/39 was valued at 15 points on P.S. Strain. It is much earlier and the G.O.T. is generally two to three per cent. higher. Taking all these facts into consideration, it has been decided to bulk up N.T.58/39 as a second string, in case Deltapine should be unsaleable.

Some new selections from S.P.20 and S.P.84 show possibilities of becoming suitable substitutes for varieties at present being grown in Equatoria.

PROGRAMME OF WORK, 1942-43 SEASON.

Small-scale propagation of new strains will be proceeded with concurrently with their first tests in Line Tests and Varietal Test Plots.

Larger scale propagation of :—

N.T.96/40 (57 × Over The Top)

A roguing plot at Lagowa.

N.T.58/39 (Punjab Early outcross).

A first increase area of approximately 50 feddans.

Deltapine (Delta and Pine Land Co. No. 11A).

A repeat "1st increase area" of approximately 70 feddans at Damgamad, and a second increase area (sown with "first wave seed") of approximately 700 feddans at Berdab.

The sub-station will continue on established lines with attention to purification and improvement of N.T.58 type and re-selection for longer and less harsh staple in Deltapine. Some S.P.20 and S.P.84 families will be carried on.

EQUATORIA.

(S. H. EVELYN).

Meteorology.

At Maridi 180 mm. of rain fell in November, 1941, as compared with 28·3 mm. in November, 1940. This must have had some abnormal effect on the Varietal Test.

General.

In Equatoria Province variety trials and/or demonstration plots were sown at two sites in Maridi, at four sites in the Luluba Hills and at Kagelu. At Maridi Farm and Onga the varieties 511 E, S.P.20, S.P.84 and S.P.102 were tested against 511 D—the local variety, and demonstration plots of N.T.91/40 and Deltapine were grown for observation. In the Luluba Hills the varieties 511 D, 511 E, S.P.20 and S.P.84 were tested against XA129—the local variety, and demonstration plots of Deltapine were grown. At Kagelu S.P.84 and 511 D were grown in an unreplicated plot for observation.

In the variety trials early and late sowing and "local weeding" and "clean weeding" treatments were superimposed on the tests at random. The statistical results for these tests are not yet available, but the following main points can be deduced.

In the Maridi area there was little difference in yield between the varieties, although S.P.84 gave the lowest yield at both the Farm and at Onga, and 511 D, 511 E and S.P.102 gave the highest total yield in this order. Deltapine, mainly because of jassid damage, but also because in the randomization it was handicapped by falling into "local weeding" treatments, gave poor results at both sites. N.T.91/40 showed up well at Maridi Farm in an inspection plot and gave a high yield. The site on which it was grown was very fertile, however, and so further trials of this variety in comparison with others are necessary.

At Kagelu, S.P.84 gave a superior yield to 511 D in the unreplicated trial and this difference is mainly attributable to the high shedding of the latter variety under humid conditions.

In the Luluba Hills, with the exception of the demonstration plots of Deltapine in which yields were low mainly on account of jassid damage, there was not much difference between the yields of the other varieties although they all outyielded XA129—the control.

Yield differences between superimposed treatments varied with sites. Thus in the Maridi area there was no difference between early and late sown treatments but the yield from " clean weeded " treatments was markedly superior to that from " local weeded " treatments. These results were reversed at the Luluba Hills site where " early sown " treatments heavily outyielded " late sown ", but the yield difference between " clean " and " local weeded " treatments, although in favour of the former, was much less marked.

[*Included by courtesy of the Uganda Government.*]

UGANDA.

COTTON EXPERIMENT STATIONS, KAWANDA AND SERERE, PROGRESS REPORTS FOR THE SEASON 1941-42.

Introductory Note

BY

G. W. NYE

Acting Director of Agriculture.

The 1941–42 cotton season was very disappointing. Weather conditions were generally unsatisfactory and resulted in a much reduced crop of 230,000 bales. Prices paid to the grower were low, especially for the poorer quality growths which were not in keen demand.

Improvements in spacing were again recorded and the growers are beginning to realise that closer spacing increases yields per acre.

Propaganda to encourage strip cropping has continued and results are very satisfactory in most districts. There is no doubt that soil consciousness is gradually spreading amongst the African cultivators. It is now the exception rather than the rule to see cotton planted up and down the slope ; a change which has been effected within a comparatively short time.

Further distribution of the new variety B.P.52 was made in Buganda. The quick maturing character of this variety is readily recognised and welcomed by growers as it enables them to uproot and plant their food crops earlier than was possible with Buganda Local variety. The value of the lint is 4 cents higher than that of Buganda Local and the commercial ginning percentage is nearly 1% higher. The effect of this on prices to the grower is that he gets one shilling more per 100 lb. seed cotton, equivalent to a total of nearly £10,000 with a normal crop in Buganda.

No new variety was available in the Eastern Province, but improved strains of N.17 are being increased for distribution. A somewhat unexpected development is the indication that cotton varieties bred at Bukalasa in the elephant grass zone are doing better in the short grass zone than varieties bred at Serere. This may be a matter of luck, but it is a matter which needs careful following up as confirmation would possibly make it desirable to consider a reorientation of our cotton-breeding policy.

KAWANDA ZONE

BY

J. D. JAMESON.

Introduction.

Staff changes made it impossible to do more than adhere to routine, but the programme was carried to a successful conclusion—first by Mr. A. J. Kerr, Agricultural Officer, and then by Mr. C. G. Hansford, Senior Plant Pathologist, who took over towards the end of the season.

Meteorology.

The total rainfall in 1941 was 48·69 inches, the average for 5 years being 46·66 inches. Distribution followed the 5-year monthly averages very closely except that the last two months were rather unusually wet. Elsewhere in the country November and December were so abnormally wet that much damage was done to the cotton crop, and with disturbed marketing conditions militating still further against it the commercial crop was very slender indeed.

Agriculture.

Routine experiments on cotton cultivation have been pursued very thoroughly and to a large extent successfully concluded at Bukalasa Experiment Station, the forerunner of Kawanda. Although conditions at Kawanda are somewhat different from those at Bukalasa the checking of this work is not a pressing matter.

Interplanting of Cotton.—Preliminary observations indicate that groundnuts and beans can be interplanted successfully in Buganda ; soya beans will not thrive in cotton ; and tepary beans grow well but spoil the cotton.

Genetics and Breeding.

Selection Plots.—Eight " families," each consisting of eight or nine strains, including controls, were laid down in eight separate randomized trials (balanced incomplete blocks), each single plot consisting of 5 plants. Considered as variety trials the material provided some information, but it was too fragmentary for the intelligent selection of single plants. All plants were inoculated with *Verticillium* wilt and sprayed with Blackarm, but the latter process was not as successful as could have been wished and the technique is being overhauled.

The B.181 family was markedly resistant to both Blackarm and wilt. It yielded well and had a good ginning percentage, but the lint was irregular. The BP.50 family was irregular for Blackarm and wilt (this family is usually regarded as highly susceptible to wilt). It yielded well and had a fair ginning percentage, but the lint, although long, was weak. The BP.52 family was markedly susceptible to

Blackarm and also developed an unexpected amount of wilt. The yields were poor, but both ginning percentage and lint were very satisfactory. Three trials were devoted to sifting imported material which, as would be expected, was very variable. Two trials dealt with crosses and back-crosses between BP.52 and B.181, all of which gave a good all-round performance, except that the lint was irregular. The controls used throughout were fuzzy-seeded Buganda Local and BP.52 bulk. The former led in seven trials out of eight, a significant difference being attained in one of the seven. It would be a mistake, however, to attach importance to anything but the broader indications of these small-scale trials.

Simple unreplicated plots were planted containing recent importations from other countries, a comprehensive collection of Buganda Local seed types, and a diversity of crosses and back-crosses between our own cottons and imported cottons of various species. Most of this work was exploratory, and the seed type collection proved very baffling as there were probably at least three genes involved deriving from *G. barbadense* as well as *G. hirsutum.*

It is being borne in upon us that Uganda conditions present many factors tending towards a high rate of cross-pollination. Consequently there are relatively frequent accidents to the techniques of self-pollination and artificial hybridization. It will be as well to face this fact and to be frankly critical of the validity of material wherever there is cause for doubt.

Variety Trials.—The main trial at Kawanda was planted on May 16th and gave these results :—

	Blackarm lesions per plant.	*Wilt. %*	*Total seed cotton. lb. per acre.*	*Ginning. %*	*Clean Lint. lb. per acre.*
Buganda Local	3·5	37	621	29·1	141
Fuzzy-seeded Local	4·1	55	500	29·8	120
BP.52 Kawanda	3·1	15	792	31·7	206
BP.52 Bukalasa	4·1	20	758	30·8	188
B.181	0·6	22	906	32·9	254
BP.213 (ex B.181)	0·2	14	856	31·7	229
X.3/1938	1·5	15	893	31·8	241
X.3/1941	2·1	23	792	31·8	215
BP.50.S6.	2·5	25	854	31·4	224
Sig. Diff.	1·1	none	111	obvious	31

X.3 is a mixture of 75% BP.52 and 25% B.181. The 1938 mixture had been grown as a mixture. The 1941 mixture was freshly composed. A small-scale repetition of this trial, planted later and sprayed with Blackarm, did not add to the information.

A small trial to investigate the seed type question gave the following results (Blackarm and wilt data were inconclusive) :—

	Total seed cotton lb. per acre.	*Ginning %*	*Fuzzless seeds produced %*
Buganda Local	465	29·72	66·7
Fuzzy-seeded Local	503	30·70	22·8
Fuzzless-seeded Local	485	29·31	90·5
Sig. Diff.	none	0·53	obvious

The correlation between fuzzless seeds and low ginning percentage was worked out and was very highly significant, thus concluding the proof of the hypothesis previously put forward for this relation in Uganda. No fear is felt that there may be an inescapable relation between fuzzy seed and rough lint because our two best quality cottons, SG.29 and BP.52 both have fuzzy seed, the former in very marked degree.

District variety trials were planted according to the usual plan at ten centres in Buganda, Kawanda itself being added to the previous list.

	Blackarm lesions per plant.	*Total seed cotton lb. per acre.*	*Ginning %*	*Clean lint lb. per acre.*
Local	3·2	1,070	29·4	271
BP.52	4·6	1,149	31·1	307
B.181	0·7	1,245	32·1	351
X.3	1·9	1,224	31·6	336
Sig. Diff.	obvious	59	obvious	not calc.

There were some variations between centres, but none of great importance.

Seed Farm and Segregated Area.—BP.52 was planted once more in order to provide a new wave of pure seed. Judged by seed type, however, the produce proved to be no purer than that already growing in the succeeding stage, so it was used to make up a local deficiency in the bulk supply elsewhere.

Spinning Tests.—The Shirley Institute report on 1940–41 samples placed BP.52 first with X.3 a good second, although the latter had the better yarn appearance. B.181 and N.17.M2 were next and both better than Local, but BP.213 (ex B.181) was only just equal to Local. The range of the Highest Standard Counts was 75 down to 39. The Indian Central Cotton Committee reported BP.52 equal to Local at 45 Highest Standard Count with B.181 and X.3 three points higher.

Entomology.

There were no major field problems on cotton at Kawanda, but some basis work on *Lygus* was carried out by Dr. Taylor in order to strengthen the background of the work at Serere.

Mycology.

Blackarm and wilt were considered largely from the standpoint of genetics, and the work has been described under that head.

Summary and Conclusions.

The end of the year was very wet and disturbed marketing conditions also combined to make the commercial crop a very slender one.

Considering the balance of a dozen trials, BP.52 gave a higher yield than Buganda Local. Eight miniature trials in the Selection

Plots tended to give an opposite result. B.181 gave the highest yields of all and was also markedly resistant to both Blackarm and wilt, but it had irregular lint. Mixtures of BP.52 and B.181 did well, and also achieved good spinning reports. BP.50 yielded quite well, but its susceptibility to wilt was not brought out by the counts this year.

The relation between fuzzless seeds and low ginning percentage in Buganda Local was proved conclusively.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1942-43.

Agriculture.

Interplanting.—Observation plots only.

Genetics and Breeding.

Selection Plots.—(*a*) Genetics of seed type ; (*b*) genetics of Blackarm resistance ; (*c*) genetics of resistance to Verticillium wilt, if any.

Variety Trials.—Routine trials.

SERERE ZONE

BY

J. D. JAMESON.

Introduction.

It was a year of stock-taking, and a large number of varieties were tested in trials, before embarking on some rather different lines of work. At the end of it the black seed question, work on which was already well advanced, was settled for all practical purposes ; and it was clear that the Blackarm problem had to be approached anew along the lines followed by Knight and Clouston in the Sudan.

Meteorology.

The total rainfall in 1941 was 58·84 inches, the average for 20 years being 53·70 inches. The distribution over the first ten months was admirable and early observations on plant height, *Lygus* and Blackarm were taken under ideal conditions. In November and early December over 10 inches fell and did irreparable damage to the crop. From then on cropping became a contest in boll opening, and unusual influences were at work. Some Serere yields were good in the circumstances, but the local commercial crop was very poor indeed. The late crop, which might have been expected to do well, produced hardly any clean cotton.

Manurial Trial.—The third cropping cycle (ninth year) closed with groundnuts. The groundnuts responded to the residual effects of farmyard manure, but even so the yield level was appreciably below that elsewhere on the farm.

Cotton Seed and Meal Manurial Trial.—A final crop of *Eleusine* was planted and gave very large responses to the residual effects of both manures. There was more lodging on manured plots and there was also more lodging on plots where the residues of the previous cotton crop had been dug in. Some pigeon peas were sown with the *Eleusine* and the plots were allowed to rest under this and natural grass after the *Eleusine* had been harvested.

Cotton Seed and Ash Manurial Trial.—A crop of *Eleusine* followed the first crop of cotton and responded handsomely to the residual effects of manures, particularly seed. These increases in yield, however, were accompanied by a sharply mounting tendency for the crop to lodge, and this tendency was particularly strong on those plots which had received the heaviest dressing of seed. Manures were then applied a second time and a second crop of cotton was planted on July 11th. *Lygus* damage and plant height increased together with increasing doses of manure. Although increased plant height is almost certainly an effect of *Lygus* damage, owing to bud suppression, it was impossible to sort out from the data the full inter-relationship of *Lygus* damage, plant height and manuring. Localized applications of seed brought about a great increase in *Lygus* damage. Seed as opposed to ash supplies nitrogen and conserves moisture by its mulching effect when applied thickly round the plant. This result therefore supports the hypothesis built up from many sources that *Lygus* damage is associated with the succulence and nitrogen status of the plant. Localized applications of seed were again found to breed *Dysdercus*. The jassid population was never large enough for treatment effects to be demonstrated. Owing to late planting and the resistance of the varieties used, Blackarm did not develop to a sufficient extent to be interesting. The yields were not good, even for the season, and only one result emerged. The heavy late rains made everything manured with seed go to wood, so that the yields of all these plots were depressed. Both kinds of manuring depressed ginning percentage, but it was difficult to pin down this effect to increased seed weight. The lower ginning percentage was more marked with seed than with ash. A subsequent crop of *Eleusine* again gave very large responses to the residual effects of manures, but this time the heaviest dressing of seed caused such severe lodging that less grain was harvested than from plots which had received lighter dressings.

Fertility Experiment.—For the first time it seemed that under the conditions of this experiment farmyard manure checks Blackarm at some level beyond $2\frac{1}{2}$ tons per acre. There was no effect on yield. It would not have been surprising if the wet weather in November had

brought about too much vegetative growth on the manured plots with consequent loss of yield. There was also more Blackarm after the longer resting periods, but the reason is not known.

Interplanting Experiment.—The design of the previous year's trial was retained but the cotton was interplanted with tepary beans instead of groundnuts. The tepary beans retarded the growth of the cotton plants very noticeably, the outside rows of cotton (which were discarded before harvest) being twice the height of the middle rows. But the shorter plants suffered less *Lygus* damage. It was impossible to say whether the reduction in *Lygus* damage assisted yield, but it was probable that the reduction in yield due to interplanting did not correspond to the reduction in the size of the plants. The general sowing date affected the yield of cotton profoundly as it always does in contiguous plot experiments, but to the tepary beans it was immaterial. In this respect tepary beans were much more satisfactory than groundnuts. It seemed to matter very little to the tepary beans or the cotton whether one or two lines of beans were sown ; the easier course is to plant one. As a result of interplanting, about a quarter of the yield of cotton was lost. But for every pound of cotton lost between three and four pounds of beans were gained. On the face of it this is a paying proposition, but it must be remembered that many other factors such as the quality and ginning percentage of the cotton have yet to be studied, nor is it at all certain that this part of Uganda could market a pound of beans with every pound of cotton. A limited application of this system of interplanting, if there are not other objections, would, however, make an important contribution to the native food supply.

Gap-filling Experiment (*Serere and Ngetta*).—At both places the stand was adjusted artificially to three levels 11 days after planting : 83% (best possible), 70% and 50% at Serere ; and 85% (best possible), 60% and 40% at Ngetta. At Serere there was a significant drop in yield at the low stand. The highest yield was realised from the medium stand at both places, but this was not significant. It is known that perfect 3 ft. × 1 ft. spacing is a little closer than the ideal.

At thinning time different plots were thinned to one, two and three plants per hole. At Ngetta the plants made a tall rank growth and more than one plant per hole was too many. At Serere growth was irregular and on the whole rather stunted so that the very opposite was true.

Finally, half the plots had all gaps filled and the remainder did not. This was also done 11 days after planting. Gap-filling did not increase yield, and there was no tendency whatever for gap-filling to give more advantage at the lowest level of stand. Therefore the hypothesis that gap-filling does not benefit yield still stands, and the inductive basis on which the conclusions rest has been made substantially wider. The material was not uniform enough to show whether gap-filling checked the development (height) of the original

plants. The plots with artificially reduced stands yielded fewer black seeds, the effect being more marked on those plots where the gaps were not subsequently filled.

Planting Methods Experiment.—One set of plots was planted 3 ft. × 1 ft. making the holes with native hoes in the ordinary way and using ordinary seed. The other set of plots was planted in continuous lines 3 ft. apart, using seed treated with mud and water so that it had the consistency of sheep dung. The spaced planting consumed 15·2 lb. of seed per acre and realised an 84% stand; the gaps were not filled. The continuous planting consumed 12·4 lb. of seed per acre and realised a 72% stand after singling: it was also about 9% quicker once the men had got into the way of it.

At a later date the plots were again sub-divided into two. One set was weeded five times in the period July–December, and the other set was weeded four times in the same period. Fewer weedings reduced the yield. The heavy November rain made weed growth very troublesome. The spaced plantings suffered more from lack of weeding than the continuous plantings.

Genetics and Breeding.

Selection Plots.—There was no change in the organization of the plots, and the process of reducing a wide range of material to a number of well-defined types was concluded. These types were carried forward for a final sorting of the fuzzy-seed character and for a new programme of obtaining resistance to Blackarm. In addition, sufficient seed was obtained from most types to run medium-scale trials concurrently with the proposed breeding programme.

The first series of Serere hybrids was tested in a variety trial. The second series, and the series received from Nyasaland, were planted in rows again to raise sufficient seed for a medium-scale trial.

A start was made with a permanent type collection.

Variety Trials.—Work on uniformity allowed a general change over to square blocks divided into long narrow plots. Longitudinal paths between plots were eliminated altogether, but transverse paths were retained between blocks. A most notable result of the change was the ease with which varieties could be compared by eye. Furthermore, the trials built up a uniform field of cotton, and to that extent the cotton was growing under more natural conditions than in separate small plots. From the statistical point of view the result was to increase very greatly the number of varieties under test, provide guard rows, reduce net plot size, and still hold the percentage standard error at about the same figure.

There were four trials embracing 80 varieties. Growth was good and uniform and some very interesting eye comparisons were possible in the field before *Lygus* had had time to spoil the appearance of the plants (as it eventually does every year). Observations were then

made on *Lygus*, jassid and Blackarm. In yield the B.P.50 family was far ahead of everything else, followed by B.181. The three Nyasaland Upland types emerged in the order B.P.52, N.17, S.G.29. N.17.M.2 was again an improvement on bulk. Black (fuzzy tip) seed and white fuzzy seed sorted from the same bulk of N.17, gave ginning percentages of 29·6% and 30·1%, the interval being significant.

Several of the parent types appeared to have deteriorated. In this connection, it is necessary to expand the second paragraph on Mycology on p. 87 of our progress report for the season 1939-40. The progeny of a plant heterozygous for one gene would give a 3 : 1 ratio for Blackarm resistance. Succeeding generations, either in the breeding plot or in increase plots, would, with increasing homozygosity, tend to approach a 1 : 1 ratio. This change would simulate loss of resistance. The point not mentioned in the published paragraph is that self-pollinated material in our breeding plots usually undergoes a certain amount of roguing and this would tend to preserve the 3 : 1 ratio. Retention in the breeding plots has therefore put off the time when strains are free to attain genetic equilibrium. When at last we have left them free to do this we have been correspondingly disappointed. All this, however, is conjectural until we have a better knowledge of the genetic make-up of our material.

In the trial of the first series of Serere hybrids no one variety combined yield, lint and ginning percentage, although several varieties combined two of these characters.

District trials were conducted at 20 centres. Amongst the Nyasaland Upland types S.G.29 was worst, and B.P.52 tended to be better than N.17. The re-selections from N.17 were better than bulk. B.181 did well and seemed to have better lint than S.P.84. B.P.50 was far ahead of everything else wherever it was included.

Seed Multiplication.

The increase of N.17.M.2 in Busoga was carried to a stage of about 250 acres, but yields were disastrously low throughout all that part of Busoga and the produce only served to " wash out " the next area. Serere farm was planted with N.17 from Ngetta ginnery in Lango (the purest available) after removing all black and green seeds (about 25% of the whole). The produce contained less than 10% impurity, ascribable to open pollination in the previous generation. Seed purity in all the areas served by Serere was watched as a matter of routine.

Spinning Tests.

B.P.52, B.P.50 and B.181 were the best spinning cottons. The last two appear to do much better in short grass country than in Buganda, where they were bred. Some B.P.50 manured with 10 tons farmyard manure per acre had only 19% dead hairs as compared with a control giving 32%.

Entomology.

Lygus attack on cotton began in the latter part of July and was perhaps a week or two later than usual. Damage was not more than ordinarily severe. The attack passed off at the end of September in the usual way.

Jassids were present in normal numbers and did not do any noticeable damage at Serere. But at Vukula in Busoga there was a substantial attack and the resistant B.P.50 stood out in marked contrast to the other varieties all of which were of Nyasaland Upland origin and susceptible. At Serere, a relatively severe attack was induced in one of the trials by the inclusion of some very susceptible varieties.

Mycology.

Blackarm.—Blackarm was severe in many parts of Teso District, but at Serere itself it was not abnormal. We are now aware that our lesion counts are the summation of a number of effects of which inherent resistance is only one. Other effects are the amount of primary infection carried by the seed and the size of the plant. The publication of the work of Knight and Clouston* in the Sudan has put this subject in a very different light. Both the authors visited Uganda during the year and there were valuable opportunities for discussion. It is possible, however, that Blackarm in Uganda is controlled by a number of genes and modifiers and that a single observation which represents the summation of them will always have some value.

Summary and Conclusions.

The crop was poor after a very wet November.

Experiments on general agronomy gave information on *Lygus*, Blackarm, fibre quality and ginning percentage in relation to manuring and different ways of resting land. Interplanting cotton with tepary beans brought about some loss of cotton, but gave a big return of beans. Gap-filling did not benefit yield. Planting seed in continuous lines after treatment with mud used less seed and took less time.

A large number of types were brought together in the cotton breeding plot, and most of these were purified for fuzzy seed and then carried on for examination for Blackarm resistance. The number of varieties including hybrids tested in trial was very large, and general information was collected about them all. The relation between fuzzless seeds and low ginning percentage was demonstrated. The record of the B.P.50 family was very remarkable in the season under review.

Seed multiplication encountered difficulties owing to very low yields.

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* Knight, R. L, and Clouston, T. W. (1939). *J. Genet.* **38**, 133–159, and (1941) *J. Genet.* **41**, 391–409.

B.P.52, B.P.50 and B.181 were pre-eminent in spinning tests.

Entomological and mycological work consisted mostly of routine observations on *Lygus*, jassid and Blackarm in connection with plant breeding.

EXPERIMENTAL PROGRAMME FOR THE SEASON 1942-43.

Agriculture.

Manurial Trial.—To continue.

Cotton Seed and Meal Manurial Trial.—Resting.

Cotton Seed and Ash Manurial Trial.—To continue.

Fertility Experiment.—To continue.

Interplanting Experiment.—(*a*) Cotton with tepary beans and cow peas ; (*b*) Cotton with cassava and pigeon pea.

Planting Methods Experiment.—To be repeated.

Gap-filling Experiment.—To be repeated.

N, P, K, Experiment.—Investigation to be started with a miniature trial.

Genetics and Breeding.

Selection Plots.—(*a*) Genetics of seed type ; (*b*) genetics of Blackarm resistance.

Variety Trials.—Routine trials.

TANGANYIKA TERRITORY.

PROGRESS REPORTS ON COTTON WORK 1941-42.

INTRODUCTORY NOTE

BY

R. W. R. MILLER

Director of Agriculture.

It will be seen from the reports on Ukiriguru, Lubaga and Kingolwira, how problems of fertility and pests affect the work of the cotton breeder, and it is clear that the Corporation's staff are acquiring much local knowledge of the conditions under which cotton is grown which will be very valuable to them as their work becomes more centred on actual selection and breeding. One has only to draw attention to the soil types mentioned in these reports, to the presence of *Callidea* in large numbers, and to the destruction wrought by the American bollworm to show how different these conditions are from those ruling in neighbouring cotton-growing countries. It is rare to find an improved strain from elsewhere giving a satisfactory performance in Tanganyika and it is felt that only local work carried out in typical surroundings can be expected to produce or discover the sought-for cotton combining resistance to jassid and other pests, with good yielding properties and somewhat improved staple. It will not be out of place to stress the importance of staple. While no great advance need be aimed at, the trend of cotton affairs in the Indian market makes it important that no staple length should be lost in the process of improving yield and other qualities. The Corporation's Officers have not writtenover much about their breeding and selection work, possibly through modesty and inherent caution, but they have some very interesting and promising material which augurs well for the future.

It was a very great pleasure to have Mr. F. R. Parnell with us during August and September, when the future of the work at Kingolwira came under consideration. Since his visit, the possibilities of other sites for a cotton station have been further examined and the selection of a trial piece of land near Kilosa will it is hoped be made very shortly.

The crop planted in 1941–42 was not one of the biggest. The weather resulted in much water-logging and favoured the spread of pests. In the Lake Province the normal acreage produced approximately 32,000 bales as compared with the five years' average of 36,400 bales. The same conditions affected the coastal belt also and, in addition, economic factors such as competition with highly-priced food crops for war production reduced the acreage. In the

circumstances the estimated production of 47,000 bales is not unduly low compared with the five years' average of 63,880 bales during the period 1937–42. The growers were fortunate in escaping by a few months a very severe depression in prices. In fact, on the rebound, they received much more for their cotton than for many years.

UKIRIGURU EXPERIMENT STATION.

PROGRESS REPORT FOR THE SEASON 1941-42

BY

J. E. PEAT.

Introduction.

It has been a wet season, yet, in much of the Province, with a droughty February and early March. The cotton crop, excluding Shinyanga district covered by Lubaga, is only about 65% of that of last year, with somewhere around the same acreage planted. There was water-logging on the heavier soil types, but the main reason for the drop in crop was severe jassid attack, more widespread than in past years.

At Ukiriguru a considerable amount of work has been done in levelling and developing the new area of light land. The developing of this area is proceeding as fast as present conditions allow. Soil irregularities, unavoidable in any conversion of an area of small native holdings to experimental use, have hampered to some extent accurate trial work, and will continue to do so for a year or two.

The visit of Mr. Parnell, and the opportunities which it afforded of discussing the problems were greatly appreciated.

Meteorology.

The Ukiriguru rainfall for the growing season, November 1st to June 30th, was 38·76 inches. Nearly 18 inches fell in November and December. February and early March were droughty, with 3·26 inches for the two-month period from the second week in January to the second week in March. Following the leaching of light land, this was a trying period for crops, where the land was in poor heart. The excessive rain at the beginning of the season made the heavy black soils very difficult to work ; only crops established there early did well. In areas where January and February were not as dry as at Ukiriguru, and where a considerable portion of the soil is of the heavy type, cotton and food crops were a failure, and there is food shortage.

Fertility — Manuring, Rotation and Resting Crops. — Fertility problems of the lighter soils represent an important side of the Ukiriguru work. Comparing Ukiriguru millet (bulrush) yields from unmanured land with the crops on native shambas, it is estimated that a considerable amount of the millet grown in the area around Ukiriguru must have been yielding under 400 lb. per acre, and what maize was grown even more poorly. A rough survey amongst 60 cotton growers, representative of the country immediately around Ukiriguru, showed that 46 of them seemed to have picked under 200 lb. per acre of Grade A seed cotton, and 35 picked 100 lb. per acre or less.

The heavier soils are naturally more rich : and in the Province there are large areas of light soil still in good heart. But great, densely populated areas in the districts of Mwanza and Kwimba are in a low state of fertility. It is interesting to record that on the extension plots in two long-settled areas, the land, though deep, was so exhausted by continuous cropping that it was with the greatest difficulty that the cultivators could be persuaded to plant any grain for rotation.

Ukiriguru cotton yields vary from well over 1,000 lb. seed cotton per acre under the most favourable conditions (the effects of jassid and American bollworm attack have to be mentioned later) to under 200 lb. on unfertilised land in the new area. " Local," under such conditions, badly jassid struck, yielded 175 lb. per acre : nearby, manured and following a green manure, though still struck by jassid, it yielded 920 lb. per acre. Whatever strain improvement may be effected must be lost partially unless the level of fertility of much of the lighter land can be raised, and the fertility level in the more newly settled areas maintained.

Manuring.—Insect damage has nullified the response in two cotton manurial trials. In the millet portion of the one trial, on land in good heart, manuring at the rate of 3–5 tons per acre gave just over 20% increase of grain, with a control of 900 lb. per acre. In the other, on land in the new area in fairly poor heart, 5 tons of manure per acre gave 44% increase of millet, with a control of 500 lb. per acre.

That with the Ukiriguru types of soil there is some second-year benefit from moderate applications of manure can be seen by contrasting growth on repeatedly manured lands with that on lands which have not been manured ; but this residual benefit seems to be small.

While the maximum of manuring is advocated, it is doubtful if it is going to have much influence in raising the level of fertility in the more exhausted areas, or in maintaining it on the light soils in the newer areas. In practice little manuring is yet done, and that in a sketchy fashion. Little bedding is used, and as a result very little manure is in fact available. It looks as though, supplementary to all the manuring that can be done, resting crops may be the possible approach.

MANURIAL, AND COTTON ROTATION TRIAL, 1942—SECOND YEAR RESPONSE.

1942 Bulrush Millet	*Mean yield lb. per acre*				*Mean counts per acre*			
	Millet grain		*Millet Stalks plus heads*		*Number of plants*		*Number of heads*	
Treatment in 1940-41 season : Cotton and Millet manured	*following* Cotton	Millet	*following* Cotton	Millet	*following* Cotton	Millet	*following* Cotton	Millet
Stalks 3 tons/acre plus farmyard manure 2 tons per acre	970	695	4,600	3,220	15,250	12,500	47,000	29,400
Pen-trampled wastes—5 tons per acre	920	715	4,430	3,150	14,400	12,180	45,000	29,500
Farmyard manure—5 tons per acre ...	865	700	3,940	3,580	12,850	12,180	40,500	31,600
Stalks—5 tons per acre	810	700	3,900	3,260	13,700	12,700	35,600	28,100
Compost—5 tons per acre	800	655	3,620	3,100	13,100	13,140	34,400	24,300
Control	810	710	3,740	3,240	14,100	13,000	37,800	28,500
Least significant difference	149		—		—		7,492	
Mean percentage increase	24%		24%		10%		40%	

INTERPLANTING AND ROTATIONAL TRIAL, 1942—SECOND YEAR RESPONSE.

1942 Bulrush Millet	*Mean yield lb. per acre*				*Mean counts per acre*			
	Millet grain		*Millet stalks plus heads*		*Number of plants*		*Number of heads*	
Treatment in 1940-41 season : Cotton and Millet following poor green manure crops dug in 1940	*following* Cotton	Millet	*following* Cotton	Millet	*following* Cotton	Millet	*following* Cotton	Millet
Crotalaria and Tephrosia spp.... ...	960	754	4,350	3,320	12,100	9,680	42,000	30,700
Velvet Beans	887	708	3,780	2,950	12,000	7,800	38,400	29,600
Sunnhemp	945	825	4,100	3,520	12,200	10,000	42,000	34,200
Pigeon Pea	812	680	3,400	2,800	12,000	8,850	35,000	27,400
Control	825	795	3,550	3,380	12,100	9,540	35,800	31,000
Least significant difference	—		—		1,652		—	
Mean percentage increase	18%		20%		32%		26%	

There is very little rotating of grain and cotton by cultivators, the same areas year after year growing the one or the other. This lack of rotation seems to be the cause of a loss of crop. The two trials summarised above show more than 20% more grain from millet following cotton in rotation, compared with two years' millet. These results are similar to those of last year. Bearing in mind the Province acreage planted to cotton it would seem that if the rotational benefit could be properly utilised, though possibly not spectacular to the grower, in the aggregate it would result in considerable gain to the community.

The greater vigour of the rotated plots, and the better plant stands, were noted early in the season : there was greater tillering and there was less loss of young plants. This may have been linked up with the heavy early rains and the leaching of the top soil.

Millet is not noted as a delicate responder to gradations of fertility. This coming season maize will be tried as a register of the rotational benefit. It seems to be a one-year benefit only, no differences showing up in the third year of trial. One question to be answered is how far the response is related to the vigour of the cotton growth.

Resting Crops.—The resting crop observation plots planted in 1940 and thus down for two seasons, were dug in just before the rains—all top growth was incorporated as well as roots. Growth had been good. One lot was manured at digging-in to help break-down ; the other lot was not. With the grasses, the dug-in material adversely affected the cropping of both millet and cotton, even with the addition of manure.

In the manured block, cotton recovered partly and finished a fairly good top crop. Where pigeon pea was dug-in plus manure, millet gave a high yield of around 1,600 lb. per acre ; tillering was marked.

This year, elephant grass, giant star grass (*Cynodon*), and pigeon pea planted early in 1941, were dug-in just before the end of the rains to give a chance for break-down during the dry season. In half the area the elephant grass top was removed for cattle bedding, and only the roots dug-in. In other blocks elephant grass has been burnt off.

Two resting crop trials have been laid down, one to compare different resting crops, the improvement they effect, and the period of years for which such improvement is effective : the other is to test the same sort of thing, growing and handling elephant grass in different ways. Elephant grass would seem to be the most practical resting crop for much of the area. Apart from its value as a possible soil regenerator, it would have grazing and other uses in the native economy. In the district this season, plots of elephant grass and pigeon pea were established without difficulty.

In the new area at Ukiriguru, land when levelled was put down to a mixture of sunnhemp and the Ukara legumes, *Crotalaria* sp. and *Tephrosia* sp. This was a success. The sunnhemp covered the ground for the early period, and the more slow-growing Ukara *Crotalaria* and *Tephrosia* covered the ground and continued to grow during the dry season, when the sunnhemp had ripened.

Tie-ridging on the light land (tieing of the ridges with cross ridges at intervals in the furrow) stood up to the heavy rains. It prevented wash along the furrow in heavy rains, and helped to hold light showers in dry periods.

Cotton Spacing.

Cotton Spacing Trial—Mz.561.

Spacing on 5′ ridges	*Maximum plant density per acre*	*Mean yield of seed cotton in lb. per acre*
2 Rows per ridge × 24″ × 2 Plants per hill	17,000	756
3 Rows per ridge × 24″ × 2 Plants per hill	26,100	708
2 Rows per ridge × 12″ × 2 Plants per hill	34,800	706
2 Rows per ridge × 36″ × 2 Plants per hill	11,600	674
1 Row per ridge × 24″ × 2 Plants per hill	8,700	671
3 Rows per ridge × 9″ × 2 Plants per hill	69,600	646
Least significant difference	—	56

Jassid and American bollworm attacks have reduced the value of the Ukiriguru spacing trials. The results from one are given above. In the other, on poor land, but with little bollworm attack, 2 rows per ridge × 24″ × 2 plants per hill, led with a mean of 440 lb. seed cotton per acre, and the least dense spacing, 1 row per ridge at the same spacing was the lowest yielder with a mean of 380 lb. per acre. In both trials there was little in it. Under the conditions of the season the closest spacing, 3 rows × 9″ × 2 plants, looked too close, resulting in somewhat stunted plants.

District Plots.

SPACING.

Yields of seed cotton expressed as percentages of the standard spacing 2 Rows per ridge × 12" × 2 Plants per hill.

(4 Replications at each centre)	*Soil type*	*Maximum plant density per acre*	*(34,800 plants)*	*(34,800 plants)*	*(8,700 plants)*	*(2,900 plants)*	*Mean yield: lb. seed cotton per acre*
		Pests	*2 Rows × 12" × 2 plants*	*3 Rows × 18" × 2 plants*	*1 Row × 24" × 2 plants*	*1 Row × 36" × 1 plant*	
MWANZA DISTRICT: UKEREWE: Nansimo	Lake shore sand—moderate fertility	—	100	113	110	94	1,095
Bulamba	Hill sand—exhausted	—	100	135	94	67	340
Ilangala	Hill sand—recently forest; high fertility	Severe jassid	—	—	—	—	—
UZINZA: Arugongo	Lake shore sand—high fertility	Fairly severe jassid	100	155	100	84	340
Ibondo	Hill sand—high fertility: "miombo" bush	Severe jassid, and capsid	100	105	84	60	206
NASSA: Bukabile	Lake shore sand—exhausted	—	100	114	112	71	605
Shigala	Hill sand—high fertility	—	100	100	78	41	1,100
MSALALA: Kharumwa... ...	Seepage area, moderately heavy soil—high fertility	Severe jassid, capsid, Callidea and stainer	—	—	—	—	77
KWIMBA DISTRICT: Mabuki	Medium heavy soil—moderate fertility	Jassid and American bollworm; stainer.	100	100	77	59	590
MASWA DISTRICT: Lalago	Medium sand—moderate fertility	Some jassid	100	89	73	55	515
Nkologoma... ...	Medium heavy soil—good fertility	—	100	99	64	49	860

In the district spacing trials, given favourable growing conditions, at the wider spacings plants were able to make up for the less dense stands, but they were less able to do so under poorer and drier conditions. Allowing for the importance of plant stand, the closer spacings used are probably the safest.

Time of Planting—Ukiriguru.—Most of the cotton was planted around the third week of November. Cotton planted at the beginning of February yielded just over 100 lb. per acre.

Other Crops—Ukiriguru.—Sorghum varieties established early in the heavy black bottom soil, yielded around 1,200 lb. per acre. Early planting was very difficult. Later-planted sorghum yielded less. It was only in January that the maize could be planted and yields were miserable—about a bag an acre. Groundnuts do not do well at Ukiriguru. On the seepage area and on the hill sand with reasonable treatment and in spite of a good show of haulm, they yielded only around 400 lb. per acre unshelled nuts—not a good return for the labour involved.

District Plots.—In an area with conditions as diverse as are those of the Lake Province it is necessary to test out strains, and generally to supplement the findings of the station by means of district plots. This season thirteen extension plots were started, controlled by embryo recorders from Ukiriguru. There were many mistakes, as was to be expected in a first year with an inexperienced recorder staff, and with the plot cultivators somewhat doubtful of what was happening. But much useful information has been obtained. One plot on heavy black soil was completely water-logged ; one was wiped out by hail ; and two suffered crippling insect damage. The plots gave a cross-section of what was happening in the districts this season.

Mwabagole Rice Station.—The dry February and early March set back the rice at Mwabagole more than in many growing areas. Crops were fair. Most plots were yielding around 1½ tons of paddy to the acre. Pure seed of the varieties Afaa, Maji Maji, and to a lesser extent Sena Mtebe, has gone for distribution in areas where seed stocks are mixed. Three other varieties of interest in the field are being tested for milling and quality. The 1941 selections from Afaa were multiplied. A number of new selections were taken, mainly from the variety Afaa.

Cotton Breeding.

In last year's report it was stated that cotton in this area should be to some extent resistant to jassid, and that without this there was a risk in any year of heavy loss. This year has shown that a high degree of jassid resistance is essential : the heavy loss has occurred. As stated before, the problem at Ukiriguru is to breed for high jassid resistance combined with as high a degree of lint quality as is possible, plus, of course, the other necessary field qualities. Mz.457 has little resistance ; Mz.561 in areas suffered quite seriously from jassid ; even Mz.561/6 showed distress. Many of the U.4 lots, including most of the better-linted lots, showed insufficient resistance. Strains with a high degree of resistance exist in both the Lake and the U.4 material ; the difficulty is to find this in combination with the other qualities desired.

The Ukiriguru strain trial results are masked somewhat by an evening-up of jassid damage in the single ridge plots—at first some protection from jassid of the less resistant strains, and possibly the reverse, namely, some bombardment later in the season of the hairier strains. It raises problems of trial technique. The susceptible strains almost certainly showed better yields in the trials relative to the more resistant strains, than bulks showed ; and yields better than would be obtained in general cultivation in years when jassid was bad.

In the trial area American bollworm took the bottom crop and caused damage—the greater where growth was good. The crop attacked was therefore thrown late, and there was some staining of the later crop. As a result, some of the best grown cotton yielded no better than somewhat stunted cotton on very much poorer land. The American bollworm–stainer position at Ukiriguru this year is probably associated with the particular circumstances of the year.

COTTON STRAIN TRIAL.

On hill sand—planted mid-November—17% Grade C.

Strain	*Mean yield of seed cotton in lb. per acre*	*Mean yield of lint in lb. per acre*
G.9L18 (ex U.4)	815	315
Mz.561	810	263
"Local"	745	244
B.6250 (ex U.4)	743	286
G.7C92 (ex U.4 × Cambodia)	690	228
Least significant difference	77 lb. seed cotton	

G.7C92, a strain with good jassid resistance, was significantly poorer than Mz.561. It is not sufficiently productive.

In a second trial 561/6 gave the heaviest seed cotton yield, 705 lb. per acre (216 lb. of lint); with Mz.561, 671 lb. (214 lb. of lint); G.9L18, 635 lb. (234 lb. of lint); and "Local," 580 lb. (185 lb. of lint).

On heavy black bottom land—planted early January—25% Grade C.

Strain	*Mean yield of seed cotton in lb. per acre*
Mz.561/6	395
G.7C92 (ex U.4 × Cambodia backcross)	326
Mz.561	303
G.9L18 (U.4)	267
Mz.457	257
"Local"	216
Least significant difference	29 lb. seed cotton

Owing to the wet state of the ground this trial could not be planted until the beginning of January. It suffered capsid and some jassid damage. The yielding of Mz.561/6 and G.7C92, the two hairiest lots, may be important. G.7C92 is not sufficiently productive under the hill conditions.

District Plots.

YIELDS OF LINT EXPRESSED AS PERCENTAGES OF "LOCAL."

(4 Replications at each centre)	*"Local"*	*Mz.561*	*Mz.561/6*	*Mz.457*	*G.9L18 (U.4)*	*B.6250 (U.4)*	*Mean Yield: lb. seed cotton per acre*	*Percentage seed cotton Grade C*
MWANZA DISTRICT:								
UKEREWE:								
Nansimo	100	85	103	91	117	106	1,030	18%
Bulamba	100	135	186	131	192	161	216	26%
Ilangala	100	134	188	132	160	134	256	5%
UZINZA:								
Arugongo	100	130	116	99	164	125	511	7%
Ibondo	100	160	165	122	112	150	95	6%
NASSA:								
Bukabile	100	85	94	94	105	93	732	21%
Shigala	100	109	92	109	115	125	1,480	13%
MSALALA:								
Kharumwa	100	—	—	—	—	—	58	23%
KWIMBA DISTRICT:								
Mabuki	100	168	157	155	170	210	279	34%
MASWA DISTRICT:								
Lalago	100	120	131	107	151	156	508	7%
Nkologoma	100	95	101	96	112	122	910	7%
Mean Ginning Percentage	32·0%	32·0%	31·3%	32·7%	36·0%	37·1%		

Given good growing conditions, and without insect attack, " Local " has yielded surprisingly well. Where conditions were poorer the quicker-fruiting strains have shown up. Where jassid was severe the strains with some resistance yielded considerably better. None of those in the district trials has high resistance. Mz.561/6 has fair resistance ; it is penalised by its low ginning percentage, and possibly lacks sufficient vigour for poor soils. G.9L18 has insufficient resistance, though better than B.6250, which is also too fine for general use.

Further selection work and the multiplication and testing of the range of " possible " material continue the most important of the Ukiriguru activities. None of the 1940 selections is worth carrying on, though one ex Mz.561, because of its high degree of jassid resistance and desirable habit, will feature in the experimental work, but the lint is too short and harsh. There is more promising material in the 1941 selections. One of these may be a sufficient improvement to follow up Mz.561. The area under Mz.561 is being extended to the limit of the seed available. On all the evidence available this seems sound.

G.9SP278 ex Uganda BP 50 combines good lint, good jassid resistance, and good fruiting on good soil. The fruiting habit differs from that of most of the U.4 and Lake strains. It will have to be tested further under a range of conditions.

Five Uganda lots were planted slightly later than most of the Ukiriguru cotton. The most interesting one at Ukiriguru, BP 50S6, was similar to G.9SP278 and from the same stock. It yielded better and looked altogether happier than its neighbours, BP 52 and B 181, which suffered severely from jassid.

Spinning Tests.

Samples from 1941 Ukiriguru and district lint were submitted to the Shirley Institute and to the Technological Laboratory of the Indian Central Cotton Committee. Brokers' valuations were also obtained. Some of the results were slightly conflicting. The general conclusions were that there was little to choose in length between the various Lake and U.4 strains submitted. " Local," grown under good conditions, was as fine as the other samples submitted and gave on the whole as good a spinning performance. Mz.561 and Mz.561/6 were similar in their fibre qualities to well-grown " Local," but in most samples were very slightly below " Local " in spinning qualities—there was very little in it. They were well valued by the brokers. None of the lint was from jassid-struck crops. The differences between lint from jassid attacked crops and crops not so attacked will be followed up this year. Mz.457 did not show the improvement over " Local " which was expected, while Mz.561/6 on the whole showed up better than had been anticipated. In spinning qualities none of the U.4 lots submitted was quite equal to " Local," though some were similar in fibre properties. G.9L18 did not spin as well as the brokers' valuations would have indicated.

The Highest Standard Counts for the Ukiriguru material were around 35s–40s. The same strains grown in the districts gave higher counts up to 50s. The same material in India was judged suitable for spinning up to 33s–37s warp counts, and in the districts up to 43s.

In a small-scale spinning test G.9SP278 (ex BP 50) gave the strongest yarn, though slightly neppy, and though the most mature, showed a low mean hair weight.

Entomology.

Jassid.—Jassid was more widespread and caused more damage in the Province than has before been recorded. In areas of the districts of Mwanza and Kwimba, the attack, especially on the poorer soils, was crippling. Contrary to what has been observed in other seasons, the attack was also very severe under favourable growing conditions in Ukerewe and Uzinza. Jassid was much less important in Maswa district, and unimportant in eastern Mwanza where the rainfall was less. Most of the drop in crop compared with last season must be attributed to jassid damage, and as part of the Province suffered little, it is a loss concentrated into the areas where attack was heavy. A high degree of resistance is required. Mz.561 suffered considerably at Ukiriguru and in the Uzinza area.

At Ukiriguru jassid was noticed in fair quantities as early as the middle of March, and from then on it got worse. Cotton on poor land suffered much more than cotton on land in good heart: there, considerable populations of nymphs were present, but the damage was insufficient to prevent a good crop being set. "Local" on poor soil suffered badly and finished with a yield of 175 lb. seed cotton per acre. Nearby, on land which had been green manured and manured, "Local" yielded 920 lb. per acre: jassid was present early in the season, but did not seem to be able to destroy the plants. Yet probably the richest district plot, on Ukerewe Island, suffered very severe jassid damage: yields were poor.

Amongst the cotton strains grown, there are degrees of hairiness up to virtual immunity.

American Bollworm.—In areas in W. Mwanza where early rains allow the planting of at least some maize in October–November for early food, loss is caused by American bollworm. In one area this loss is so heavy that, on top of other insect damage, cotton-growing is scarcely worth while. This early source of food is valued more than the cotton. In most of the Province American bollworm is not important.

At Ukiriguru, headmen planted maize with the first rains. The heavy early rains favoured this, and allowed more to be planted than in most years. It is thought that American bollworm bred up on this early maize, and possibly on pigeon pea, provided the generation which caused the loss in early March. There was just the one generation, and only the middle portion of the hill, where the main trials were,

suffered badly. The bigger grown cotton suffered most, and because of this, plots on unmanured land with much poorer looking, smaller grown plants, yielded better than some of the bigger, manured, cotton. In the attacked area, the bottom crop was lost, and as a result the crop there was thrown late. The later crop suffered some stainer damage.

It seems probable that this attack is particular to the Ukiriguru Station conditions of this season, and probably will not be of frequent occurrence. On the Station in future no maize will be planted until about a month after the time of cotton planting, and all pigeon pea will be ratooned.

Stainer.—*D. superstitiosus* and *D. nigrofasciatus* were present in the cotton in small numbers in mid-February. The numbers increased during the season. In May small numbers of *D. fasciatus* and *D. cardinalis* were observed. No population figures are available. The damage they were able to do in the bigger grown cotton is probably the more noticeable because the American bollworm attack made the crop there late. The amount of staining at Ukiriguru, and in the district plots, is shown by the percentages of Grade C cotton. This is hand picked from the cotton harvested, and is mainly stained.

At Ukiriguru the main trial on good manured land, attacked by American bollworm, showed 17% Grade C cotton. Nearby, an area of small growth, on land unmanured for three seasons, gave only 6% Grade C.

Numbers of *Callidea* were noticed through the season, probably not in sufficient numbers nor continuous enough in their presence to be important. In some of the district plots *Callidea* adults were present in large numbers as early as February.

Capsid.—At Ukiriguru capsid did damage on the heavier bottom lands. The higher yields from the hairier cotton strains in the heavy land trial may be important. This will be followed up.

There was some capsid damage on the light hill land. The jassid damage caught the eye ; it is possible, however, that loss later in the season was caused to this crop by capsid, more than was at first thought.

In the same way there may have been more non-spectacular capsid loss in the districts than was thought. Spectacular capsid loss is obvious, but much of the lesser, more insidious, loss of buds and growing points may be overlooked.

Aphis.—Aphis was again bad in the second half of February and early March. It caused stunting then, and some loss. It disappeared when the rains improved in March, and the plants recovered.

Summary and Conclusions.

1. Though a wet season, there was a drought in February and early March. The November–December rains were exceptionally heavy.

2. It was a bad jassid year for cotton : more than ever is the need apparent for breeding for a high degree of jassid-resistance.

3. An American bollworm attack, possibly particular to the seasonal conditions at Ukiriguru, affected trials and some of the better grown cotton, causing loss of the early crop. There was some staining of the later crop.

4. The insect damage has obscured to some extent in the actual trials the benefits to cotton resulting from manuring; but the improvement of crop resulting from improved soil fertility is obvious.

5. With millet, a 3–5 tons an acre application of manure has raised yield by 20–40%. The rotational benefits to millet following cotton in the rotation are recorded, an increase in yield in the neighbourhood of 20%. If this rotational benefit could be properly utilised, it would result in gain to the cultivator.

6. The second year benefit from manuring is not striking; and in view of the very small quantities of manure which the cultivator seems able to make, and of the low order of fertility of large areas of the Province soil, work on possible resting crops is important.

7. Cotton selection and testing proceeds. The cultivation of Mz.561 is being extended to the limit of the available seed. It shows lint quality akin to that of "Local." Mz.457 has no jassid resistance, and reports on lint quality do not show the improvement on "Local" anticipated. Mz.561/6 shows value in the field, but has certain defects. In the selected material there are "possibles" with the essential qualities of jassid resistance, yielding power, and lint quality, in varying degrees.

8. Thirteen extension plots were started in the districts of Mwanza, Kwimba, and Maswa. Already useful information has been obtained from them.

9. The development of the new Ukiriguru area of light land is proceeding as rapidly as present conditions permit. Seed farm and other farm activities are being maintained.

10. The full acreage at Mwabagole Rice Station was planted. Conditions in February and early March were not favourable. All the pure seed of the varieties Afaa and Maji Maji, which is available, is in keen demand. Selection work in Afaa, mainly for bolder grain, proceeds.

PROGRAMME OF EXPERIMENTAL WORK 1942-43.

Soil Fertility, Manuring and the Value of Cotton in the Rotation.—This work will proceed much as in the last season—manuring, resting crops, and the following up of second year manurial and rotational responses.

Cotton—Cultural Practices, Breeding, and Strain Testing.—Cotton selection and testing are the most important of the Ukiriguru activities. Nothing without a high degree of jassid resistance is "possible."

Strain trials and the testing of new material will continue. Supplementary evidence from trials and observation plots will be obtained from fifteen district extension plots. Both at Ukiriguru and in the district plots there will be cotton spacing trials.

Rice.—At Mwabagole Rice Station there will be a trial of three possible strains, against the two main, established, local strains. The four best 1941 Afaa selections will be tested against local Afaa in a small trial.

LUBAGA EXPERIMENT STATION, SHINYANGA

BY

A. N. PRENTICE.

General Introduction.

This sketch of the district served by Lubaga may give those unacquainted with the conditions some idea of the local agricultural background.

Inherent Agricultural Circumstances.—Shinyanga is a political district of the Lake Province. As districts go, it is small and compact, covering about three-and-a-half thousand square miles. The native population is probably a quarter of a million, of whom fifty to sixty thousand are adult males. The natives form part of the industrious agricultural tribe, the Wasukuma, and administration is based on "indirect rule" through about a dozen local chiefs. The district is a purely native one.

The gently rolling countryside is mostly just above the 3,500′ contour. In the settled areas, speaking generally, the vegetation is open grassland, with the baobab the only conspicuous tree; but some of the more recently settled areas show predominantly acacia thorn-tree or thorny scrub vegetation.

Large stretches of land are uninhabited because of lack of water, but these are being gradually opened up by conserving water in "tank dams." There are no permanent rivers in the district, and in the dry season water is got chiefly by digging in the sandy river courses.

The rainy season is from November to May, and the rest of the year is virtually rainless. A 30-inch rainfall might be regarded as "normal"; the range at Lubaga over the last nine years has been from 24 to 49 inches. Rainfall in the rainy season is often badly distributed and heavy storms are fairly common. Lake Victoria is too distant to influence the climate of the district. Temperatures rarely drop to the lower fifties, and the maxima mostly run between 80°F. and 95°F. The daily range of temperatures may reach 30°, but the mean annual range is not pronounced. Length of day at this short distance from the equator shows little variation.

The cotton areas cover not much over half of Shinyanga. About a sixth of Shinyanga is tsetse " fly " country and almost uninhabited, and the remaining non-cotton areas are unsuitable for the crop, largely because of the insect pests.

The main soil types in the cotton-growing areas are a blackish loam, a good agricultural soil where it has sufficient depth ; and a black soil (found in areas liable to waterlogging, known locally as " mbugas ") which is agriculturally heavy and cracks markedly at the end of the rains, but seems to be of good inherent fertility. Red loams and lighter sandy types are also common, but are often played out. The Shinyanga native has a nice appreciation of soil types, and distinguishes several main groups with many subdivisions and gradations. A survey by the District Agricultural Officer, Mr. R. B. Allnutt, shows that (1941) 30% of the district cotton is on " mbuga " land, 40% is on " ibushi," the calcareous black loam which is the typical Lubaga soil, 16% is on sandy loam or red loam type soils, and the remainder is on miscellaneous comparatively unimportant types. The black loam " ibushi " is the most popular type for cotton when obtainable ; it seems to have a good reserve of fertility, stands a good deal of abuse, and is easily worked, but is often on the shallow side and is as liable to erosion as any. It responds to organic manure, on the evidence of a number of Lubaga experiments, but not to the same extent as the sandy soil types, although the evidence from the latter is limited to general experience and a few local experiments. It is generally accepted that the " mbuga " soils, heavy black types which fissure on drying and which exist in near-swamp conditions, do not respond to manuring, and no manuring experiments have been carried out on them, to my knowledge.

Erosion is serious on all except the " mbuga " types. This is only to be expected with the dense population, the concentration around water supplies, the overstocking and the type of climate. Fairly high winds in the dry season add to the erosion on the scantily clothed soil.

The Native Agricultural System.—In the cotton areas there are about thirty thousand taxpayers with a theoretical average of over 30 acres each, of which probably about five acres is cultivated annually. Under their indigenous system the occupiers seem to have fairly good security of tenure. There are few or no large-scale farmers ; fencing or hedging is conspicuous by its absence ; large stretches of one crop are often grown together, each owner looking after his own portion ; grazing land is largely communal. The cattle, zebus, are numerous but are not used to any extent as work-oxen. Cultivation is done chiefly with the hand-hoe, and the women share in most of the agricultural work.

Sorghum is the chief food crop. The other grains include millet and maize, and recently rice. The groundnut crop is important ; supplementary food crops are beans, cassava and sweet potatoes. Rice and groundnut sales now help with the cash income, and income from livestock sales and stock products is important, but even so the

main source of cash is cotton. The average cash income per taxpayer is probably under £2 per year, but may be nearer £4 in a year of good cotton crops and good cotton prices.

Cotton is now an accepted crop. Each taxpayer grows an acre on the average, and the crop in the cotton areas occupies something of the order of 3% of the total land. The distribution of the population, however, is far from regular, and uncultivable stretches of poor soil, etc., must account for an appreciable though unknown proportion of the "total land." Cotton yields—and yields of other crops—are low, the seed cotton average per acre being of the order of 250 lb. in most years. The gospel of mixed farming has been preached to the district for some years, but in general it can be said that very limited use is made of manure. Neither green manuring nor rotation of crops in the ordinary sense is practised, although interplanting of grain crops with legumes has its place in the native system. Much of the soil is down to poverty bottom, and pressure on the land allows it insufficient time for any real rejuvenation under the natural grass fallow into which it sometimes lapses. Damage to grain crops by witchweed, *Striga hermonthica*, is very serious in many parts. Witchweed in itself would constitute a full-time district problem. In extreme cases of played-out soil or growing witchweed infestation, the native uproots himself and moves for preference into the newer areas which are being opened by the provision of water supplies. Unless the pertinent lessons can be driven home, these new areas will go the way of the old, as the traditional husbandry, or lack of it—thoughtless, rather than lazy farming—still holds sway.

Native Agricultural Practices.—With his traditional food crops the native is pretty shrewd in his agricultural practices. With cotton, however, he is only just beginning to acquire lore. There are still a few old men in the district who used to spin and weave a local cotton, probably the kidney cotton of which some bushes still grow in the locality, but there seems to have been no commercial growing of cotton until the Germans made an attempt just before the last war. About 1925 cotton got started properly in the district. It is planted almost universally on the flat, and planting dates show a great range ; much accumulated evidence points to the benefit of early planting, and the grower is beginning to appreciate this, especially now that he is no longer apathetic to the crop ; quite naturally, he gives first thought to his food crops when rains break and he can cultivate his lands, but he realizes now that a late planting of cotton is usually wasted effort. Spacing varies from broadcasting, a reasonable practice if thinning is carried out early, to rough line-planting at very variable spacings ; here again the grower is beginning to follow the proved advice to space more closely than his wont. Thinning is carried out, but often late in the life of the plant and there is room for much improvement in this respect. Weeding, too, although finally thorough, is often carried out at such a late stage as obviously to depress the potential yield.

Marketing, etc.—Picking is done with care, to give a high grade cotton and a residue of " stained " cotton. The two grades of seed cotton are sold at well-sited buying posts throughout the district. The one ginnery in the district has a virtual monopoly of cotton buying. Prices are fixed by Government ; they range from 6 or 7 cents per pound of seed cotton in a year of low prices to 18 cents or so in a year of high prices, and the grower probably considers anything over 10 cents a good price (cent =1/100 of a shilling). The stained cotton usually sells at 1 cent. The local ginnery, efficiently managed, is equipped with roller gins—probably quite unnecessarily considering that the staple runs about one inch. The ginnery draws from Shinyanga district only, and turns out an average of, say, 5,000 bales yearly. The railway to Dar-es-Salaam runs through Shinyanga, but the haul to the coast is long. Surplus seed is usually allowed to go to waste. Seed supply to the growers through this one ginnery presents few difficulties.

Relationship of Lubaga to the district.—The natives are generally illiterate, and the extension work of the District Agricultural Officer is largely carried out through his body of about thirty African Instructors. Before the war, the district had one Agricultural Officer and one Agricultural Assistant, who ran the District and Lubaga Station between them. The present position is that there is no Agricultural Assistant ; the district has normally one full-time Agricultural Officer, and Lubaga is run by a Corporation Officer. Full co-operation is, of course, maintained between the two.

Lubaga, a Station maintained partly by the Native Authority and partly by the Government with its own and Corporation funds, has been running since 1933. Land is ample, buildings and office accommodation are just adequate, and lack of water is a serious problem in the dry season. The Station was started primarily as a seed farm for the issue of improved seed stocks of all kinds to natives, and for demonstration-cum-experimental work generally. In recent years it has become largely a Cotton Station. The soil is a black loam (locally, " ibushi ") and is representative of the most important cotton soil type in the district, but is not representative of the remaining three-fifths. A drawback to the soil experimentally is its patchiness. At a depth of two feet on the average the soil is underlain by a sharply demarcated nodular limestone zone, and this lack of depth makes for precarious cropping in a dry year. The lands have been well protected by contour-banks and cassia shelter-belts. Climatically, Lubaga and the district are similar.

The Station lacks laboratory equipment, and the experimental work is very much " field." Cotton investigation is now the main concern of the Station. A limited amount of work is done on other crops : keeping seed stocks pure, testing of new types from other stations and some sorting-out of local grasses and legumes. Breeding apart, yield work is concerned with findings which have an immediate effect on the efficiency of yields in the district, whatever the state of

fertility—experiments on such factors as spacing, time-of-planting, type of cultivation ; and with the longer-term fertility work proper, including rotational effect. The cotton breeding aims at producing the type best adapted for the district, a type that is jassid-resistant, not " delicate " but as early-maturing as is compatible with this, with the best quality lint which the environment will allow, and, of course, with the best lint yield possible. Cotton insect studies in the field are as intensive as possible. Jassid and stainers are the main pests of Shinyanga cotton, but two of the bollworms, and various plant bugs are also important ; cotton pests play an important if not over-riding role in determining yields here.

The Lubaga work is linked up with the district by a chain of district plots. This side of the work has been greatly expanded recently. Constant touch is kept with Ukiriguru, which is the main Experimental Station of the Lake Province and is a bare hundred miles north of Lubaga, and the respective areas served have a good deal in common. The cotton pest position, however, shows some marked differences.

Summary.—In brief, the basic facts about Shinyanga district are that it has good natural resources in the way of an industrious population, fair ones in respect of original soil, bad ones in respect of water supplies ; and a climate suitable for annual crops such as cotton. The land has been abused by failure to rest, manure, or preserve it properly, and much of the soil is in a low state of fertility. Crop yields are poor on the whole. Cotton, nowadays popular, is quite the most important source of cash. The crop is confined to about half the district, with probably rather more than half the population. The non-cotton areas cannot grow cotton successfully because of insect pests, especially stainers and other boll-suckers, and even in the cotton areas insect pests are very serious—just how serious, it is one of the main functions of Lubaga to investigate. Concurrently with insect survey, work is done on *ad hoc* breeding for jassid resistance and investigations on how best to dodge pests by changes in cultural practices. The standard of cotton cultivation in the district can be raised appreciably, and on Lubaga as much experimental work as possible is directed to bettering yields by improving cultural practices and soil fertility. The strain of cotton grown in the district is no better than it should be and can be improved probably appreciably for yield and somewhat for quality ; cotton breeding, with its concomitant yield trials, both on Lubaga and in the district, is a main line of work.

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In general, work has continued on the lines of the past two seasons, but the system of district trial plots has been greatly extended. These district plots, for investigation rather than demonstration, act as a necessary check on whether particular Lubaga results hold generally ; moreover, they serve as " sampling-points " for insect records, crop estimates, or other data.

A very wet season interfered to some extent with farming operations. The red soil extension to Lubaga was inaccessible for the season, and a rotation trial on Lubaga had to be abandoned, but otherwise the programme was carried through as planned.

Meteorology.

Rainfall from November to May inclusive was 49·22 inches. This is the heaviest fall since Lubaga started recording in 1933. May, as usual, was a fairly dry month, but all the other months except February were very wet; February, luckily, was dry enough for cleaning operations, but not so dry as to check growth. Although there were three storms of over 3 inches during the season, including one of 4·74 inches, the soil had a good cover and erosion was not as bad as might have been expected. The bulk of the Lubaga cotton was planted early, mostly in early December, and growth was good throughout the season.

The season was similarly wet throughout Shinyanga district. Although it suited the well-drained soils, crops in the flat areas known as "mbugas" were waterlogged and failed, and famine relief was necessary in some of these areas.

Agriculture.

Manuring.—Last season, a very dry one, farmyard manure at 6 tons per acre showed a significant increase of 77 lb. per acre of seed cotton, or 20% over the control treatment, at a fairly low level of yield. This season, a very wet one, the same dressing of farmyard manure gave a 21% increase over the non-manure treatment at a high level of yield—950 lb. per acre of seed cotton against 782 lb. from the control, with a difference of but 109 lb. wanted for significance at P=·05. A compost treatment and a stalk treatment in this trial did not yield significantly more than the control, although elsewhere on the farm compost gave results every bit as good as farmyard manure, to the eye. (Demonstration of the relative efficiency of different types of organic manures is only half the problem. The native probably does appreciate the benefit of manuring. But although dung—usually desiccated, but still dung—is available in many areas, the native very often simply fails to get it out on the lands, and the amount of manuring in the district is far from adequate. A former District Agricultural Officer, Mr. J. G. M. King, tried to popularize pack-ox transport for manuring, but the idea although seemingly sound and attractive, has not caught on and dung-carting remains a "bottleneck.")

Cultural Practices.—The manurial trial had superimposed on it four cultivation treatments. These, ignoring the manuring for the moment, gave the following results:—

Type of Cultivation Trial, on Black Loam. Strain U.4/9L18.

Treatment	*Yield in lb. seed cotton per acre*	*Control (Flat) = 100*
Flat, 3′ rows	935	100
Ridged, 3′ rows	850	91
Ridged, 5′ 10ws (spacing equalised)	807	86
Tie-ridged, 3′ rows	761	82

Significant difference (P=·05)=83 lb. seed cotton, or 8·9 in last column.

Under trial conditions, however large the plots (within reason) a flat plot has an artificial advantage in being protected from sheet erosion by the very proximity of other-treatment plots, which act as protective works. Flat cultivation is almost universal in the district, and there would seem to be little reason to alter it ; indeed, the *immediate* effect might be to lower yields, judging not only on the above results, in a very wet season when waterlogging might play an unusual part, but also on the result mentioned in last year's report when the flat was significantly better than the ridged treatment in a very dry year; but on the long view the cumulative effect of erosion outweighs all other considerations, and there is no doubt that flat cultivation is less effective than ridge cultivation or its variations in holding water and soil. Whether ridging is more effective and more feasible than some other protective measure such as contour-banking or strip cropping (which might still allow of flat cultivation in field practice) is another problem.

The tie-ridging treatment depressed growth obviously under these particular conditions, doubtless due to waterlogging. The 5′ ridges of the type in vogue on the sandy soils of Ukiriguru area did not stand up too well mechanically to the rains, but again, the unusual season has to be considered. Interaction of manurial and cultivation treatments was not significant, as was anticipated from field behaviour. The best combination of treatments, FYM-FLAT, yielded at the rate of 1,041 lb. per acre, significantly ahead of all but three of the other fifteen possible combinations.

Spacing is becoming markedly closer in the district, with a good effect on yields. Probably the majority of the district cotton is now spaced at something not more than (the equivalent of) 3′×2′ with 2 plants left at thinning. In the crude comparison " wide " versus " close," there is now no reasonable doubt of the advantage of close spacing, and work on spacing is now becoming more fastidious within the " close " range. A measured acre on Lubaga has been under annual cotton since 1935-6. This " exhaustion plot " represents only too well what happens in the district, where cotton is often grown year after year on the same land. At any rate, it was taken as being in much the same state of fertility as the run of district soil, and this year a spacing trial was superimposed on it. The very close spacing treatment in this trial is really equivalent to a controlled broadcasting, and (under this year's conditions) it seems that the critical point of plant density has not yet been passed :—

Spacing Trial, on Black Loam Soil under Continuous Cotton. Strain 6C/6 (Cross).

Treatment : spacing	*Yield in lb. seed cotton per acre*	*Control (3′×1′)=100*
1½′×1′ 2 plants per hill. Approx. 58,000 plants per acre ...	693	114
3′ ×1′ „ „ „ 28,000 „ „ ...	607	100
3′ ×2′ „ „ „ 14,500 „ „ ...	565	93

Significance (P=·05)=61 lb. seed cotton, or 10·0 in last column.

According to Lubaga measurements, which are admittedly coarse, there was no difference in lint quality between treatments. The very

close spacing, unimpressive though it looked in the field, had to yield only 5·5 grams of seed cotton or, say, two very ordinary bolls per plant, to give a 700 lb. crop.

Results have not yet been finally checked from a combined spacing and time-of-planting trial, with the same spacing treatments as the " exhaustion plot." This trial, better grown on better land, suffered much more from insect attack. The spacing yields do not tally altogether with those from the " exhaustion plot " ; at the corresponding planting date, and in general at the earlier planting dates, there is nothing much to choose between the three spacings ; but with later planting dates the closest spacing takes an undoubted lead, *i.e.*, spacing responds differentially to planting date, and it might reasonably be expected to do the same to degree of soil fertility.

The time-of-planting results show good general agreement with Lubaga results over the previous six years. So much of the success of cotton-growing in Shinyanga hinges on correct time-of-planting that attention has to be drawn to it, local though the problem may be. The district cotton, unfortunately, in spite of propaganda, is still far from being wholly planted in what is obviously the optimum month, December. Although things are improving, January is still probably the commonest planting month. But compared with mid-December, a mid-January planting shows a drop of nearly 50% in yield, and a mid-February planting a drop of over 80%. (Average of seven years.)

In the " mbuga " areas mentioned earlier, the optimum time to plant is still uncertain. These " mbugas," in spite of their habit of fissuring when dry, may retain enough moisture to mature a late planted crop that escapes insect damage, and a late planting may be Hobson's choice in some years in the " mbugas."

District trial plots were laid down this year to start testing this and other points. All the work was carried out jointly with the District Agricultural Officer, Mr. Allnutt, until he was transferred from the district at the end of the season. The sixteen plots, each supervised by a native agricultural instructor, covered the cotton-growing areas and soil types of Shinyanga. The plots, half-acre each, were designed to give statistical results on time-of-planting, two spacings and four strains. In spite of the fairly elaborate lay-out the human element was little at fault, and the system was a success. It seems to be worthy of playing an important part in the local experimental scheme. The plot failures, in the " mbugas," were a reflection of what was happening to the adjacent cultivator's cotton in such areas, and in fact the plots, heavy yielding or light, were a fair sample of adjacent native cotton of the same planting dates. Results in general showed agreement with Lubaga results. Detailed figures from this first year's results would be out of place, especially in view of the abnormally wet season, but in general terms the yields from the different soil types are of some interest :—

Black loam	(3 blocks),	crude overall yield	=	588 lb.	seed cotton	per	acre
Red loam	(3 | „),	„	„	„	=	346	„	„	„
Sandy loam	(3 | „),	„	„	„	=	240	„	„	„
" Mbuga " types	(7 | „),	„	„	„	=	290	„	„	„

The "mbuga" types especially showed wide variation in yield; two gave virtually nothing, on account of waterlogging, whereas the best two "mbuga" blocks averaged 510 lb. per acre, and the best time-of-planting plot within these blocks gave 765 lb.

Non-Cotton Crops.—("Rotation crops" would be a misnomer locally.) The non-cotton crops on the farm yielded well, except sorghum. Witchweed (*Striga hermonthica*, and *S. asiatica* to a lesser extent) was bad this season, and bird-damage was excessive on the small grains.

The resting crops under observation on Lubaga include grasses and legumes. Elephant grass on a field scale has done well in the past two years, but conditions for it may be marginal in Shinyanga. A wild grass (*Cenchrus ciliaris* ?) shows promise as a drought-resister and is said by the local cattle herdsmen to be palatable. An interesting grass under large-scale trial is a perennial hybrid sorghum obtained from the Kenya botanist; this grass is easily established from seed, has thriven well so far, and is liked by the cattle, but it has the drawbacks that it acts as a host to witchweed and stalk-borer, and it may—this is unproven—contaminate the local food sorghums by crossing. Pigeon pea has long been established on Lubaga, but little is grown in the district—luckily, perhaps, in view of the danger of breeding up American bollworm. One constituent, a *Tephrosia sp.* of a green-manure mixture obtained from Ukiriguru, is growing very well under Lubaga conditions.

Cotton Breeding.

Up to three years ago no intensive plant-breeding had been carried out on Lubaga. Improvement work centred chiefly round the introduction of ready-made strains, in the main U.4 from Barberton and Uganda Uplands from Ukiriguru. Three years ago, a representative range of Gatooma U.4 and U.4 × Cambodia strains was added to the Lubaga collection, and intensive selection was started in all the promising stocks of whatever origin. A few further introductions from Barberton and Ukiriguru have also been made.

The first of the new local selections, the 1940 class, have now reached the formal trial stage. Ten out of the twenty selections tested were yielding significantly better than U.4/998, the present district cotton. One was significantly poorer. (These twenty selections were spread over two trials, but the yield of the control, U.4/998, was exactly the same in both at 219 lb. lint per acre, and the differences needed for significance were not dissimilar, 14·3% and 15·6% respectively.)

Twenty 1940 Selections: Yield Compared with U.4/998.

Lineage	*Signif. better*		*Not signif. different*		*Signif. poorer*	
	No.	*Mean % increase*	*No.*	*Mean % difference*	*No.*	*% decrease*
Ten U.4 × Cambodia backcrosses ...	6	28%	4	+ 4%	—	—
Eight straight U.4 types	3	26%	4	− 6%	1	23%
Two Mz. (Ug. Upland) types ...	1	17%	1	+10%	—	—
Twenty, all types	10	26%	9	0%	1	23%

The heaviest yielder, one of the backcrosses, was giving 325 lb. lint per acre, or 48% more than U.4/998 ; this particular strain has good all-round field characters, and has always looked a heavy yielder. The U.4×Cambodia backcrosses in general are good yielding lots, with good hair—doubtless cause and effect, as jassid was severe enough this season to worry to some extent the less resistant strains. The lint is being sent for spinning tests ; it will probably show little advance, if any, on U.4/998, but that of the Mwanza types may be rather better. The two Mwanza strains listed above unfortunately are just very ordinary for jassid resistance.

The twenty strains put into trials seemed the most promising as progeny row plots, but a big batch of the same 1940 class was kept going in bulk plots, and half a dozen of these are now seen to have real merit in the field. One, a selection out of Mz.561, was yielding over 1,200 lb. per acre seed cotton on a 1/20 acre plot, which means little, but it is worthy of mention as being as hairy as the best of the U.4s, and as early. In habit it might easily be mistaken for a U.4 type, which, of course, is not surprising considering the origin of the latter, and the common mould of selection aims. Its lint may be slightly better than most U.4 lint, but it seems to be fatally easy to lose the initial superiority of Mwanza (Uganda Upland) over U.4 in lint quality.

Although the new strains were contrasted above with U.4/998, they are really nowadays in competition with a stiffer opponent, Mz.561. Shinyanga district grew the Uganda Upland known as Mz.Local until about 1933 ; Mz.Local was then replaced by U.4/4/2 ; U.4/4/2 in turn was displaced by U.4/998, starting in 1939, and the displacement would have been complete by this coming season, but the Indian market's call for a better quality lint, and the field advantages of Mz.561 compared with U.4/998, have led to the substitution of Mz.561 for U.4/998. All Shinyanga will be under Mz.561 next season. The seed was obtained from the Ukiriguru end of the Province. Mz.561, an Ukiriguru-bred strain, has been tested on Lubaga against U.4/998 since 1935. Apart from two years in which trials were failures, it yielded significantly less in the first two years, and thereafter has fully held its own. In 1940, a year of fair rains, it was neck and neck with U.4/998 on lint yields, and last year, a very dry season, it was level with U.4/998 in one trial, and significantly ahead in another. This season (a great contrast climatically) both U.4/998 and Mz.561 have been included in all strain trials as a sort of double control ; Lubaga had six full-scale strain trials this year, all successful, and in all of them U.4/998 was the poorer on lint yields, significantly poorer in two out of the six. In this year's district trial plots, although the figures have not been finally checked, Mz.561 leads U.4/998 (on seed cotton yield) by a greater or lesser margin in 46 out of 55 comparable sub-plots. Mz.561 may be a slightly later maturing type, but its jassid resistance, although far from perfect, is superior. As to lint quality, in samples from two 1941 Lubaga trials tested at the Shirley Institute, Mz.561 was shown to be the better lint and the Rhodesian cotton grader, Mr. Hesse, who was kind enough to

give his opinion on some small Lubaga samples, put Mz.561 above U.4/998. Evidence over a longer term of years on the quality of Mz.561 under Shinyanga conditions would have been desirable, but the decision had to be made quickly, and Mz.561 is generally accepted as having the better lint of the two.

Among the older strains U.4/9L18 again showed up well. It was included in all Lubaga and district strain trials, and on balance was about as good as Mz.561 as a lint yielder. In the Shirley Institute's tests, however, the lint was no better than the run of U.4s—not good enough in competition with Mz.561—and the jassid resistance is not first-class. The hairiest of the straight U.4s, the 7L6 group, again made a fair showing, but even in this good growing season could seemingly not overcome the handicap of their small size compared with, say, U.4/9L18. U.4/6250 kept its place as a good yielder, and the lint, as confirmed by the Shirley Institute, is undoubtedly good for a U.4, but it was just touch-and-go whether it would crack to jassid this year. Six of its derivatives obtained from Barberton two years ago show the same qualities as the parent ; in a trial none differed significantly from 6250, and 880, which was mentioned hopefully last year as showing greater jassid resistance, was this year no better than the ruck.

Among the introductions, five from Nyasaland went straight into a trial. This was chiefly to provide lint for comparison with the same five strains grown at Domira Bay. The only one which seems to be worth following up under local conditions is NC 4, a U.4 × Cambodia backcross which was yielding just significantly better than Mz.561, has good hair and may have passable lint ; the others, a U.4 × Gambia backcross, an Over-the-Top × SG 27 cross, and two U.4/920 types, were not impressive and showed varying distress under jassid.

A most interesting introduction was the MU8A obtained from Barberton. Last year's Barberton report makes particular mention of the extreme hairiness of this Malwa Upland type, and it has certainly set a completely new high standard for hairiness on Lubaga. So striking was it that it was straightway used here as a crossing parent with some good-linted but jassid-susceptible Uganda Upland types, even although in mid-season its other qualities were unknown. In fact, the MU8A finished up as an attractive enough plant, rather woody (probably due to an intense bollworm attack) and with lint short but not " impossible." It had remarkably healthy foliage, and records (left to native recorders, and needing confirmation) showed that the effective life of the individual leaf was appreciably longer than that of the leaf of less hairy strains.

Entomology.

On Lubaga, the staff of native recorders is becoming more efficient, and insect and other records are becoming more reliable. Accumulating data merely emphasize the importance of insect pests to cotton-growing

in Shinyanga. In the district, insect work is still very much at the preliminary survey stage. The district in general may prove to be less badly off as regards cotton pests than Lubaga* itself, but still bad enough for insects to be the main factor in the success or failure of cotton. On Lubaga, 1940 was a year of very heavy jassid, heavy stainer and moderate bollworm attack ; in 1941 jassid was light, and stainer was heavy late in the season ; this year the story is one of moderately heavy jassid, very heavy stainer and intense bollworm attack.

Jassid.—Jassid attack varied considerably from point to point on the farm. In the worst field, some comparatively glabrous strains in the " museum " collection soon lost the effective use of their foliage, and eventually yielded next to no crop. In this field also, in the Nyasaland strain trial containing the usual double controls, U.4/998 and Mz.561, 998 was thoroughly distressed by jassid whereas 561 was just sufficiently resistant to be comparatively unaffected at this particular level of attack ; here, the 998 yielded 36% less than 561, whereas under less severe jassid in five other trials on the farm it averaged a bare 8% less.

Jassid records showed that nymphs appeared on the cotton early in January, rose to a first peak in early March, to a second higher peak of around 1·6 nymphs per leaf in mid-April, and to a third smaller peak in mid-May before fading out in June. (These records were on strains fair but not outstanding for hairiness.) The long spread of the attack, and the succession of peaks may mean nothing more than goodish but fluctuating conditions for *Empoasca fascialis*, but may suggest that more than one species of jassid is at work. Mr. W. V. Harris†, the Senior Entomologist of the Department, found in April that *E. benedettoi* was present on Lubaga although seemingly in much smaller numbers than *E. fascialis*.

Jassid attack in the district was not heavy on the whole, but one area not seen by me was reported as suffering jassid damage.

Stainers.—Stainer attack on Lubaga was very heavy on the whole, but, like jassid, it varied in intensity from point to point on the farm. Most trials were giving between 50% and 60% of stained cotton. The " exhaustion plot " of continuous cotton, mentioned earlier under spacing experiments, suffered relatively little from stainer and gave a mere 34% of stained cotton. This plot also suffered much less from

* In the 1940 Lubaga report, speaking particularly of staining, it was stated that the position improved from the S.W. of the district to the N.E., and that the centrally-situated Lubaga was in an intermediate zone. The position in S.W. Shinyanga was so bad that cotton growing there was stopped after 1940, largely on the strength of Mr. Bebbington's investigations on insect pests in that area. Although a large portion of Shinyanga was thus eliminated from the cotton-growing area, the last two years have been district records for total crops. The intermediate zone, including Lubaga, therefore now becomes part of the outer zone of the cotton belt of Shinyanga. How well Lubaga represents this outer zone, and indeed whether any zoning as regards insect pests in the remaining cotton areas of Shinyanga is a useful concept, is still speculative.

† Mr. Harris identified or confirmed all the insects mentioned in this report.

bollworm attack than the other cotton, and it looks as if the very fact of poorer growth accounts for the comparative lack of insects. It almost goes without saying that most of the cotton on the farm was well developed this very wet season, but the drain of continuous cotton in the "exhaustion plot" is now markedly affecting growth, and the size of plant there even this year was about half that of the same strain elsewhere. The same remarks apply in general to another field where for other reasons—good soil, but complete freedom from bollworm attack and a very heavy set of early crop keeping the plants compact—shorter growth was associated with less staining.

The percentage of staining is far from giving a complete reflection of stainer attack. Bolls attacked young are shed or mummified and do not come into the picture. Crop development and loss records, in a field by no means the worst for stainer, showed that out of every 100 flowers, only some 22 came through as bolls and 10 of these were stained. The records of how the sheds should be apportioned to stainer, bollworm and other causes are not reliable. For the district the percentage of staining shown by the ginnery returns is worth little as a measure of stainer attack ; this year, for instance, the grower was getting up to 18 cents a pound for his clean cotton but he got the usual price of 1 cent per pound for his stained cotton, and there is obviously little incentive to market the latter. The ginnery returns show that only 6% of the total crop bought was stained. The district trial plots are now giving a truer idea of the extent of staining in the district. The proportion of staining in the black loam district plots ranged from 7% to 29%, in the red loams from 9% to 93%, in the sandy types from 6% to 66%, and in the " mbuga " from nothing to 43%.

On Lubaga, a recorded field showed that stainer adults, all species, rose from a slow start in February to a fairly sudden peak of over 7,000 per acre in May and a second peak of about the same size in June. In another field more heavily infested, trapped catches were averaging about 500 adults per acre per day during February, and trapped catches are but a fraction of the population. *Dysdercus cardinalis* was the commonest species in the early part of the season, and it remained at a high level, but was equalled by *D. fasciatus* from mid-season onwards. *D. superstitiosus* and *D. nigrofasciatus* were present all the season, but in small numbers. *Callidea dregii* var. *apicalis*, the only species of this *Pentatomid* found in Shinyanga, made its usual sudden influx into cotton this year in mid-February, leaving equally suddenly without breeding in early April. *Callidea* is not so easy to catch as *Dysdercus* (nor is *Callidea* attracted to cotton seed traps) and records are not reliable, but numbers were obviously large, and the insect presumably adds appreciably to the staining damage. *Callidea* was present in large numbers in the district.

In the Lubaga time-of-planting trial, where stainer was heavy, the proportion of staining increased from the earliest planting (mid-November) to the latest (mid-February), the five planting dates in order showing 66%, 74%, 78%, 76% and 84% of stained cotton.

Bollworm. — American bollworm, *Heliothis armigera*, was unprecedently severe in one part of the farm, although not abnormally heavy elsewhere. The attack occurring early in March was short, but so fierce—9 larvæ per plant at its height—that it stripped the plants of almost all buds, and the plants had to start bud formation afresh. This they did successfully, giving a strongly bi-modal flowering curve, but the later flowers were caught by the growing stainer populations. *Earias* spp. were also numerous, rising to a peak of 3 per plant, again in March. No equally heavy bollworm attack was seen in the district, but the bollworms are widespread.

This particular attack of American bollworm on Lubaga cannot be explained away as having been due to early maize, as there was no early maize on Lubaga, but some equally simple cause, such as attack *via* the pigeon pea crop, probably does apply ; and bollworm in Shinyanga does not seem to be a pest in the same class of seriousness as stainer and jassid.

Miscellaneous Pests.—Aphis was never serious.

Fungous pests are not severe in Shinyanga, but this year leaf spots were noticeable. Aerolate mildew (*Ramularia*) was fairly common in May–June. *Alternaria* was associated with some leaf fall in the continuous cotton " exhaustion plot " on Lubaga, but that plot happened to be under special watch, and *Alternaria* may have been present equally on the better soils.

District Production.

The district cotton crops were a mixture of good and bad. In the more extreme " mbugas " the crops failed owing to waterlogging, and little or nothing was reaped. The other soils did better, and the black loams showed some really good crops. Ignoring the failed crops, the yield per acre must have been over 300 lb. seed cotton, which is good for Shinyanga. The very marked improvement in closer spacing this season was certainly a contributory cause. The total crop was approximately 7,000 bales of lint, some way below last year's record crop of about 9,200 bales, but well above any other season's output.

Summary.

An exceptionally heavy rainfall was well distributed. The Lubaga cotton was planted in good time, made excellent growth, and gave good yields in spite of very heavy stainer and bollworm attack, and moderately heavy jassid. Fully half the cotton, however, was stained grade. In spite of this year's bollworm attack, stainer and jassid are considered the more serious pests of cotton in Shinyanga. Manurial and cultural trial results are discussed, always with an eye to their bearing on the district. In the cotton-breeding section, some figures are given of the yields of the best of the new local selections of varied origin, in comparison with the district stock strain, U.4/998. The Uganda Upland strain Mz.561 is to replace all U.4 in Shinyanga this coming season. Mz.561, although by no means a " final " strain,

compares favourably with U.4/998 in the essential qualities, and behaved well in extensive district trials this year. Greatly increased attention is being given to district plot work. The district cotton was good except in areas where waterlogged, and the total crop of approximately 7,000 bales of lint is the second best on record.

PROGRAMME OF WORK FOR SEASON 1942-43.

The broad problem of cotton-growing in Shinyanga can be summed up simply enough as one of low yields. Lubaga is concerned with the contributory causes. This year's programme, following in the main the same lines as last year, includes :—

Inherent Agricultural Circumstances.—1. Further yield work in the district on different soil types : some types now growing cotton are probably marginal or unsuitable.

The Native Agricultural System.—1. A rotation trial (that abandoned last year) testing rotation against no rotation, which will include manuring at different points in the rotation : there is no rotation in the district, and what manure is applied in the district never goes on the cotton crop.

2. A simpler trial, to give a quicker measure of any residual crop effect on the succeeding crop.

3. Further observation on grasses and leguminous cover or green-manure crops.

Native Agricultural Practices.—It is in improving these that the biggest immediate advances in yield can come in Shinyanga.

1. Further confirmatory work on cotton spacing, time-of-planting (especially in the flat "mbuga" areas), type-of-cultivation, and time-of-thinning, at Lubaga and in the district.

Cotton Breeding.—Most time on Lubaga is devoted to the breeding work. Fitting the variety to the environment—including jassid, (ancillary yield characteristics are the most important at this stage) will give a "free" and possibly appreciable increase in yields and lessen the chances of a complete crop failure.

1. Further straight selection and testing, the main line, giving increasing attention to lint quality.

2. Introduction of the best 1940 Ukiriguru selections.

3. Continued hybridization work with MU8A. On Lubaga, and at other stations to judge by the reports, cross material in general has done so well that further crossing work is justified.

4. Further strain trials in the district plots.

Insect Pests.—Probably the most important single cause of low yields in Shinyanga.

1. Continued breeding for greater jassid-resistance.

2. Continued insect survey records, Lubaga and district, and crop development and loss records. The insect work is still largely at the survey stage, and continuing records will be kept, to find what intensity of attack and degree of damage are probable over a term of years, and what chance there is of controlling any of the factors involved in the spread of pests (particularly stainers).

3. If time permits, a study of the expression of hairiness, which seems to fluctuate markedly from one soil type to another in Shinyanga.

KINGOLWIRA EXTENSION FARM, 1942.

A NOTE ON RECENT DECISIONS AND FUTURE WORK

BY

A. H. McKINSTRY AND A. G. BEBBINGTON.

Introduction.—The necessity of submitting the annual Progress Report on work done for the Eastern cotton-growing areas of Tanganyika a year in arrear is under consideration. The reason is that as the bulk of the crop is planted about March, and uprooting does not take place until mid-November in most seasons, it is impossible to prepare a full report in time for it to arrive in London early in December when other reports are due to arrive.

The purpose of this note is to review the main observations made on crops at Kingolwira and in other areas over the past three years, and to indicate the nature and arrangements for future investigations. The whole field of work was discussed with Mr. Parnell during his visit in August and September, 1942.

Areas and Crop Production.—To date, the survey has covered the cotton-growing districts of the Eastern and Northern Provinces; there remain the Southern Province and the Rufiji district. The latter lies within the Eastern Province, but cotton is grown there under conditions which differ somewhat from those in the rest of the country.

Approximately 70% of the cotton grown in the Eastern Province is grown in areas of rich alluvial soil and good moisture conditions. The Kingolwira style of country produces very much less cotton, and conditions of soil and moisture are poorer. It is convenient, therefore, to refer to the latter areas as being " drier " in contrast with the better moisture conditions which are found in the " alluvial areas." Both types of country could support larger populations, but the alluvial areas being of higher agricultural value would probably be first considered in schemes for expansion.

Present crop production, and possible future expansion, therefore, indicate that it is the alluvial areas which should receive first attention in planning work for the improvement of the crop. That work was started in a chain of district plots this season (1942). And it has recently been decided that the main experiments on cotton problems should be transferred from Kingolwira to the alluvial type of country at Kilosa.

Insect Pests.—Observations and records taken at Kingolwira over the past three seasons may be summarised as follows :—

1940.—American bollworm caused severe loss of crop. Jassid attack was also heavy. Stainers were in the crop soon after the start of flowering, but the attack did not develop, probably because the boll population was small. Capsid damage was noted, but it was of minor importance.

Rainfall distribution was good at the start of the season, but effective rains ended early in May, about two months after planting

1941.—Little damage was done by pests other than stainers. These insects were present in the crop just before flowering started ; their attack was continuous, and damage severe.

Rainfall was patchy in distribution and very short in total quantity. The season was characterised as a very dry one.

1942.—This season American bollworm damage was severe, and Capsid and Helopeltis damage were marked. The plants produced a new flush of crop late in the season, but this was destroyed by stainer and pink bollworm attacks. Stainers were in the crop from the very start of flowering.

Rainfall was abundant and weather conditions generally were overcast. The season may be described as being very wet.

As a result of the insect damage described it has not been possible to make progress with plant breeding work at Kingolwira.

A few preliminary observations made in 1940 showed that the conditions under which the crop was being produced in some of the main areas were different to those at Kingolwira. More extensive observations on insect pests made during 1941 and 1942 in the Eastern Province areas may be summarised as follows. As has been stated previously 1941 was a dry year, and 1942 a year of heavy rainfall.

1941.—American bollworm attack was quite noticeable throughout the whole area, particularly so in the early part of the season, in the principal maize-growing area, from Kilosa to Mvomero. The early crop was damaged, but plants made a good recovery and many heavy yields of clean seed cotton were obtained. Stainer damage generally was light, being more marked on the early planted crop in certain areas. The actual numbers of stainer seemed to decrease as the season progressed. Capsid damage was serious only in the wetter patches of the Kilombero valley where weed growth was heavy. Helopeltis

damage was seen occasionally, but was serious only in one small area near Kilosa. Pink bollworm was only observed in serious numbers in a few places.

The general conclusion drawn from the observations made in 1941 was that crop finish and productivity were on a higher level in the alluvial areas than in the drier areas. But at the same time it was emphasised that observations were made in a season of low rainfall.

1942.—This season insect attack has been widespread. Many crops have been ruined by American bollworm damage to the main crop, while Capsid and Helopeltis sp. have caused a varying amount of damage to young flower buds and shoots. In some cases very good examples were seen of extreme damage due to Capsid and Helopeltis attack. Stainer caused marked damage to some crops. The presence of pink bollworm was noted on occasion.

Although insect attack was widespread, a striking feature of the damage done was that it was very haphazard in its intensity: a crop suffered severe damage while good yields were being obtained on an adjacent area. This happened over both large and small acreages.

As the reasons governing the nature of insect attack and damage this season cannot be readily deduced from the facts available, certain questions seem pertinent. Thus, how often does such an attack occur? And again, how often would it be likely to occur on the site chosen for future plant breeding work? Work will be done with a view to obtaining answers to these and allied questions. The principal object of immediate investigations will be to find out how and when the crop is produced over a range of seasons. In addition to cotton, observations will also be made on the incidence of cotton pests on other crops.

Plant Breeding.—Much will depend on the kind of results obtained from the above investigations before definite aims in plant breeding work can be formulated on such matters as the type of plant which may be required, and its rates of flowering and fruiting. It is desirable on present evidence that the plant, whatever its "type," should have a fair degree of jassid resistance. The present standards of lint quality for Eastern Province cotton must also be maintained.

It is probable, however, that, despite the incidence of pests, the ordinary commercial crop—a mixture of types—could be improved for yield, ginning percentage, and uniformity of lint by rogueing. Work will be done along these lines.

Agriculture.—Here, again, no definite methods whereby crop production could be definitely improved can at present be suggested with confidence. As a result of recent discussions, experiments to test different methods of treatment will be planted; but details would be out of place in this note.

In reference to future work it may here be noted that as all cotton areas are to a large extent infested with tsetse fly, experiments connected with cattle and mixed farming will not find a place in the programme of work.

Summary.—It has been decided to concentrate the main work on cotton in the Eastern Province at Kilosa. Elsewhere a range of District Plots will again be used.

The main object of the experimental work for the next few seasons will be to find out how and when the crop is produced in relation to the incidence of insect pests and other factors. This is at present the basic problem for the area as a whole.

Until the plant-cum-insect pictures can be more clearly stated it is premature to formulate definite aims for either plant-breeding work, or agricultural experiments generally.

NYASALAND

COTTON EXPERIMENT STATIONS.

Introductory Note

BY

H. C. DUCKER AND E. O. PEARSON.

A fairly complete description of " Cotton in Nyasaland " has been given in the *Empire Cotton Growing Review*, Vol. VI, No. 4, Vol. IX, No. 3, and Vol. XV, No. 3. The following note is a summary which indicates the relation between the principal cotton-growing problems and the experimental work now in progress :—

The cotton-producing areas of Nyasaland may be simply defined as all parts of the country below 3,000 feet elevation where topographical and other factors favour the cultivation of this crop.

It has been found by experience that the most suitable soils are those of alluvial origin which derive from the basement complex of metamorphic rocks, the heart of this part of Africa. But there are also residual soils, derived from basement complex of high exchangeable base content, hornblende schist and the like, which are very suitable for cotton cultivation. The exact definition of some apparently residual soil is not easy, " hill drift " soils occupying an intermediate place in any classification. It may be said with certainty that the best cotton soils are those with a good content of exchangeable bases, not too much leached, with fair to good natural drainage.

Generally speaking, suitable cotton soils carry bush of the Acacia-Combretum associations, defined by the Forestry Department of Nyasaland as " drier forest types," with " high " grass when the bush is sufficiently open for annual herbage to flourish.

There are considerable areas where soil conditions do not favour cotton. These are typically " Miombo," *Brachystegia* and *Iso-berlinia* spp. the common trees, with comparatively " short " grass. Their soils are badly leached, often poor and acid, and usually residual. They are closely associated with certain rock formations.

Suitable cotton soils are not confined to the 3,000 feet limit of elevation. There are large areas of good cotton land in the plateau country to the west of Lake Nyasa between the 3,000 and 4,000 ft. contours, but the difficulty in growing cotton there is the late date at which the rains break in Nyasaland. It is seldom that satisfactory planting rains occur before early December, and there is insufficient time before the onset of the dry season and cool weather for cotton to mature properly in this higher country. Certain possible solutions to the problems of the western plateau areas are ruled out at present by economic considerations.

The rainy season in Nyasaland is broadly confined to the period December–April, and the remainder of the year is dry. There is therefore only one proper growing season, but certain favoured parts, where ground water supplies provide natural sub-irrigation, have a longer growing season than the dry land areas, amounting in some cases to all-the-year-round cropping. From a cotton-growing point of view these out-of-season cropping areas are all below 3,000 feet elevation, since at elevations higher than this the climate is too cool in the winter months, May–August, for cotton to flourish. They now occur mostly in the N. Nyasa District.

The extreme south of the country is sufficiently near to the sea coast to receive a certain amount of out-of-season rainfall, known locally as "Chiperoni" weather, which occurs occasionally in May–September, months in which the remainder of the country is almost always dry. The cotton area affected by this weather is that known as the Lower River.

The Lower River area used to contain a considerable area of flood land, suited to out-of-season cropping; but the rise in the level of Lake Nyasa which has occurred in the past fifteen years, with a consequent perennially high Shire river, has put the greater part of such land out of cotton production.

The conditions briefly sketched above, the topography of Nyasaland, and economic factors, have caused the cotton areas to be divided into three main sections, which are as follows:—

(*a*) *The Lower River area.* Elevations 200 to 500 feet. Soils predominantly alluvial. Climate hot and the growing season a long one.

(*b*) *The Central areas.* Elevations 1,000 to 3,000 feet. Soils very mixed, with residual and alluvial types often occurring side by side. Growing season relatively short except in certain sections of floodland.

(*c*) *The Northern area.* Elevation around 1,600 feet, soils mixed as for (*b*), but with a much higher percentage of flood land. Conditions are such that all-the-year-round cropping is possible, but for reasons which will be mentioned later, cotton is confined to flood land as an out-of-season crop.

All the above areas are in the main African Rift valley, except for a small part of (*b*) which is found in the eastern plateau of southern Nyasaland, south of Lake Shirwa.

The Domira Bay Experiment Station is situated in the Central areas, of which it is fully representative, and it is within easy reach of a wide range of soil conditions. It is a short distance from rail head at Salima and from the steamer port on the Lake at Chipoka.

The work of this main station is supplemented by that of the Makanga Station at Chiromo in the Lower River area, and both stations are augmented by a series of demonstration and experimental

plots under the Department of Agriculture. Makanga, like Domira Bay, is controlled directly by the Corporation staff, but the activities of both stations are linked as closely as possible with the work of the Department.

There is a Department of Agriculture Station at Karonga in N. Nyasa, which, with a series of demonstration plots, represents the conditions of the Northern Area and so completes the cotton research chain.

The soil of the Domira Bay Station, a mixture of residual and hill drift types, belongs to the red-black series of tropical " chernozem," and the bush from which this station was cleared was typical Rift Valley Acacia-Combretum. It is looked upon by the local Africans as fair to good land, but is far from being the best available. It has good natural drainage, and appears to recover fertility fairly rapidly when rest-cropped. Certain fields on the Station are liable to erosion and afford possibilities for experimenting with and demonstrating anti-erosion measures.

The rainfall at Domira Bay is of a clear-cut single monsoon type, and the conditions are those of summer (rainy season) grown cotton. The elevation of the Station is about 1,980 feet, which is just warm enough for an out-of-season crop with irrigation. All the common local food crops can be grown, and the most important of these are made an object for study.

The native agricultural system of the Central areas is one of shifting cultivation and bush fallow, and though there are some practices well understood by the African for maintaining soil fertility, rotation in the accepted sense of the word is not used ; nor is stock utilised for the production of manure even where the absence of tsetse fly permits the keeping of cattle. Even in the most densely settled parts of the Central areas there is no real pressure on the land, and it is unlikely that anything more than a systematisation of the existing shifting cultivation will be possible for many years.

The African grower's main difficulty in the country represented by Domira Bay is his time-factor problem. All his crops have to be planted and cultivated within a relatively short period, and it is only in the dry season that he can work in leisurely fashion. This factor, and the competition of tobacco, a serious rival to cotton where both crops can be grown, together with the evil effects of labour export to Southern Rhodesia and elsewhere, have done much to restrict cotton-growing development in the Central areas. This is a pity, since they are the largest potential cotton-growing regions in Nyasaland.

The experimental work at Domira Bay aims at finding the best balance of crops, the most satisfactory methods of cultivation within the power of the African, and the best way of systematising his shifting cultivation on a rotationary plan. Rest-cropping, a combination of long-term crops and bush fallow, is the main line of attack on fertility problems.

The Lower River area differs from the Central areas in two ways ; first, the greater part of the area is suffering from severe population pressure, mainly due to the elimination of the flood lands along the Shire River and the resultant crowding of people on the dry land ; secondly, the high temperatures, the frequently high water-retaining capacity of the deep alluvial soils or in parts a high water table, coupled with some cool season rainfall, make the growing season for cotton a very long one.

The first circumstance has imposed continuous cultivation on the land : there is very little bush fallowing now practised, the ill effects of which are emphasised by virtually no rotation of crops, or indeed any attempt to conserve soil fertility.

The latter circumstance has enabled the African partially to overcome the disabilities of the former, by the method of interplanting his cotton in maize and millet crops. These are planted at the break of the rains and harvested in March/April. Cotton can be planted from December to the end of February and, according to its date of planting, to the character and growth of the food crop, and to weather conditions, may set its main crop any time from April to September.

This inter-planting practice is, moreover, a partial solution of the time factor problem and has a lot to do with the pre-eminence of the Lower River as a producing area. Another cause of this pre-eminence is the absence of any competing cash crop ; tobacco does not flourish at low elevations. Sheer economic necessity also compels the native to grow cotton, since it is rarely that his food requirements are fully satisfied by his own production and they have to be supplemented by cash purchases from more fortunate districts.

Rice is the only other cash crop which looks promising in the Lower River area. It competes little with cotton, and there are reasons for hoping that when the flood land areas return to cultivation, which they will do if the Lake level drops, this and other food crops will be grown on them, in preference to cotton.

The Northern area is the smallest of the three, both in acreage and production, but is of especial interest in that it lends itself to the practice of out-of-season cropping. Cotton is sown after the rains have ceased, and grows entirely as a winter crop, ripening in the hot season prior to the break of the following rains. There is virtually no clash between cotton and food crop interests, and the African's time factor is almost absent. The only real limiting factor is the acreage of flood land which is available.

The relative efficiency of production, in terms of yield per unit area, is greatest in the Northern area, intermediate in the Central areas, and least in the Lower River : 4, 3 and 2 cwts. of seed cotton per acre may be considered the relative yields. This efficiency is very largely conditioned by the presence in Nyasaland of the Red or Sudan bollworm, *Diparopsis castanea* Hmps., a most serious pest which is the ***raison d'etre*** for the present insect pest control activities of the

Corporation, and especially for their concentration, during the past three years, on the Lower River.

In the Northern area with its winter crop, and the Central areas with their summer crop, a close season and a growing season for cotton are easy of definition. It is otherwise in the Lower River, where no agreement on a single-cropping practice has yet been reached. Control of Red bollworm, which is fairly effective in the Central areas and very effective in the Northern area, is lacking. Only in exceptional seasons do natural controls operate.

The work of the Insect Pest Control Section aims at enabling a clear choice to be made between the various practices of cotton-growing which the Lower River conditions render possible, so that one may be used exclusively as in the other two areas.

Though cotton-breeding work has been attempted in all three of the areas classified above, the tendency in past years has been to concentrate this work at Domira Bay. Several factors have worked to this end, the most important being that so far a good summer crop cotton has proved equally good as a winter crop, and that a cotton which is successful at Domira Bay must have high jassid-resistance.

The advantages of a single commercial variety, in a small country like Nyasaland, are obvious. But if future work suggests that specialised strains are required for each of the three main areas, their provision will not be a difficult matter.

The existing variety, Crown Land U.4, is the original U.4 importation which has been well mixed with Nyasaland Upland, Cambodia, Over the Top, and various U.4 re-selections during the past decade. It is capable of very good yields in all three areas, and its general quality seems to have settled down at a not unsatisfactory level. It is not, however, as high a quality as one would like, and attempts are being made to breed something better without sacrificing the excellent agricultural qualities of this variety. So far, it seems as though the choice will lie between a cotton of U.4 type with fair lint quality suited for spinning 40's or thereabouts, and a longer-stapled cotton in which ginning out-turn may have to be sacrificed to quality.

The natural division of the Central areas into a number of small units makes seed supply organisation a fairly simple business, and experience in multiplying strains in the past indicates that a change-over of seed in four to five years is easily accomplished.

It may be said in conclusion of this note that given a satisfactory economic status for the cotton crop, one which will encourage growers to plant up to the potential acreage, the future of the Nyasaland industry will depend on two major factors ; one, the adoption by the African growers of sound agricultural practices, capable of maintaining or even augmenting the fertility of their land; the other, adequate control of the major cotton pest, Red bollworm.

Any other factor is of secondary importance, so far as existing knowledge would indicate.

Note on Staff (H. C. Ducker).

No staff changes took place and postings remained as in 1940/41 season.

During the year, short leave to South Africa was taken in turn by Messrs. Miller and Ducker, and Mr. Pearson also proceeded to the Union on short leave. All the staff were on duty for the critical period of harvest.

DOMIRA BAY STATION, PROGRESS REPORT, 1941-42

BY
H. C. DUCKER AND W. L. MILLER.

Meteorology.

The total rainfall for the season amounting to 36·51 inches was above the average, but the distribution was as bad as that of 1938/39, a very similar season.

The planting rains in December were ample in amount, and commenced early in the month, but they fell in a series of rather violent storms with very hot sun between times. The surface desiccation in these hot spells was sufficient to kill cotton seedlings in some plots.

January and February rains were fairly well distributed, but in March, after excessively wet weather in the fortnight March 3–17, the rains ceased abruptly on March 23. As in 1939, April flowering gave little or no cotton, and on some of the lands heavy leaf shedding occurred after the rains ceased.

The alluvial soil areas of the Domira Bay lake shore behaved better in this difficult year than did the residual soils, the cotton yield at the Salima demonstration plot and those of several commercial plantings being higher than those at the Station. In the district as a whole yields were lower than in 1941.

Agriculture.

Cotton.—The main station bulk acreage was planted to the " 920 " strain of U.4, and gave the very fair yield, for the season, of just over 500 lb. seed cotton per acre, 86% of which was clean and white.

The fields which gave this yield were part of our new clearing on old estate land which had been rested for four years under weeds and bush.

Other bulk fields, on the original station clearings, only gave yields of the order of 350 lb. seed cotton per acre.

It seems obvious that the amount of rest cropping so far adopted in the main rotation has been insufficient to maintain tilth and fertility in this part of the station, which is mainly red soil.

Leaf fall was markedly heavy, in comparison with that in the main bulk acreage, and the effects of poor tilth were obvious in certain of the heavy rain storms, when sheet erosion and surface run were bad. The problem may have been complicated by the fact that the lower yielding bulks followed a ground-nut break. All the fields involved will enter a three-year rest next season.

That the rotation is mainly to blame is indicated by results in Field 1, which forms part of the same original clearings, where plots which had two and three years' rest gave good returns not much inferior to those of the main bulk acreage.

" 920 " cotton was multiplied in large increase bulk by certain estate interests in the Salima area. Here also it gave a fair yield averaging 441 lb. seed cotton per acre. The growing was done by native tenants, and there is now sufficient seed, 100 tons, for a large-scale trial in the Central areas.

Surplus " 920 " seed from the Experiment Station is being distributed in the Mtsekwe/Makanjila area, which lies immediately between the Station and the lake shore. The balance of the S.W. lake shore areas will receive estate-grown "920," now two years away from the Station.

Though experimental results with " 920 " have not indicated that this cotton is any better as a yielder than ordinary Crown Land U.4, the African tenants on the estate growing the large increase bulk were very pleased with it. Its erect habit and storm-proof bolls probably weighed in its favour. Its lint quality is likely to be more regular than that of the C.L. U.4, and possibly slightly superior.

All plots in the large rotation experiment, now in its sixth year, were planted to " 920 " cotton. Fair to good stands were obtained, but no supplying was done, since it was thought that the effects of tilth on germination should be part of the experiment.

During the growing season Mr. Mitchell, of the Insect Pest Control Section, carried out systematic stand counts in order to ascertain what relation, if any, might exist between treatment and termite attack.

The percentage loss was the same for all twelve experimental rotations so that the effect reported last year was not, as then suggested, due to the rotation adopted at the Station. Since cotton is a better crop than maize for planting in newly cleared land, the old order for the main rotation is being restored.

The most striking results of the rotation experiment to date are those due to the effects of " rest " cropping. They were as under :—

	Lb. seed cotton per acre (Means of ten replications).	
Three years' rest under Elephant grass	427·2	Significant Differences 69·6 lb., P=0·01 52·8 lb., P=0·05
Two years' rest under Elephant grass	428·4	
Two years' rest under pigeon peas	415·8	
One year's rest under pigeon peas	356·7	
No rest at all	348·3	

The effects of two or three years' rest are easily significant, but one year's rest does little or no good to the land. There does not appear to be much difference in efficacy between Elephant grass and pigeon peas, and it would appear that the adoption of a three-year rest period will be a fairly safe practice. This will be done provisionally in the main station rotation.

There is some indication, though the evidence to date is conflicting, that ground-nuts have an adverse effect on a cotton crop which follows them. Direct experimental evidence on this point will be available next year, but provisionally the ground-nut break will be made to follow cotton.

The main rotation is now therefore an eight-course, but the crop balance, referred to last year, remains the same.

Break I	Cotton.
Break II	Maize.
Break III	Cotton.
Break IV	Ground-nuts.
Break V	Maize undersown with rest crops.
Breaks VI–VIII ..	Rest, for three years (rains).

Since the maize in Break V will receive no cultivation after February, the scheme is now virtually $4\frac{1}{2}$ years cropped followed by $3\frac{1}{2}$ years rested. It is hoped that no further modification will be necessary for some time.

Two cotton strain trials were completed; one, a small bulk trial to which further reference will be made in the section on cotton breeding work, the other, a standard strain trial.

The standard strain trial compared the local bulk of " 920 " and six strains selected from it, Barberton " 920 " and a Barberton selection from " 920 " numbered 0268, Mz.561, and Crown Land Bulk U.4. Results were as under in order of merit, Local 920=100.

Mz.561	142	
Crown Land Bulk...	110	
920–4	107	
920–1	104	Significant Differences
Local 920	100	
Barberton 920	98	17, P=0·01
920–3	98	13, P=0·05
920–2	94	
920–9	90	
920–5	77	

The excellent performance of Mz.561 is noteworthy, and work on this cotton will be intensified. It was selected at Ukiriguru, Tanganyika Territory, by Mr. D. Thornton, in hard conditions of soil and climate, which may explain its good performance in a poor cotton year at Domira Bay.

Unfortunately, its ginning percentage is at least 2% less than that of " 920," and its habit is not good when grown on rich soil. At Nyungwe, N. Nyasa, it was badly laid, a fault from which the sturdy " 920 " does not suffer.

The 0268 germinated badly and stands were so poor that it was excluded from the comparisons.

Yields throughout in this experiment were poor, and below the station average. It is hoped to repeat the experiment next year under better soil and climatic conditions. There was, however, ample material for spinning test samples, and duplicate lots have been sent for test. Results with these will be compared with those from the parallel experiment carried out at Barberton.

In 1943 also, a new experiment to ascertain the effects of two, three and four years' rest-cropping on cotton will be begun, as well as experiments on various ways of rest-cropping.

It has been suggested, from observations in native cultivations, that a simple weed fallow may be sufficient for cotton, or even the use of long term sorghum as a triennial. Experiments with both these and further Elephant grass and pigeon pea plots are being laid down.

Rotation Crops.

General.—Maize again took its place in the cultivation experiment, and results were clear cut as in 1941. Incidentally, a small correction is required in last year's Progress Report, where final yield figures confirmed " digging " differences only, a matter not made clear in the text. The effects of " late clearing " on stand were not reflected in the final yield figures where their results, about which some surprise was evinced, were actually reversed. The 1942 results may be summarised as under :—

Yields in lb. grain per acre.

No Digging	2,377	Ridged	2,195	Early Cleared	2,407
Strip Digging	2,568	Flat	2,413	Late Cleared	2,200
Full Digging	2,768				

All differences are easily significant at P=0·05, and this is one of the few occasions on which " Flat " has out-yielded " Ridged."

The ground-nut rotation experiment was continued into its second year and needs no particular comment, except that a deleterious effect by ground-nuts on cotton is suggested by yield figures. Unfortunately, since this experiment was planned to show long-term effects of ground-nuts on subsequent crops of ground-nuts, the statistical results of the ground-nut/cotton comparison need confirmation. This will be obtained by study of the residual effects on cotton of a maize–ground-nut inter-planting experiment which was carried out this year. This experiment compared maize pure stand, ground-nuts pure stand, and two methods of inter-cropping, and gave results of interest which may have a direct bearing on local native practices. Though optimum returns seem likely only from pure stands, the use of alternate rows of maize and ground-nuts may have certain definite advantages. Maize appears to benefit from wider spacing, in a year like 1941/42 at all events, than is normally used at the Station, and when so spaced is unaffected by the interplanting of ground-nuts, which latter therefore represent sheer gain to the grower.

Maize.—The large rainfall suited maize, in spite of its distribution, and since this year all maize fields were in good heart, yields were good, especially those of the Station-selected native bulk which did very well indeed with yields which ranged from 2,320 to 2,730 lb. grain per acre.

The two Peruvian Yellow stocks from Barberton proved poor yielders under Domira Bay conditions, though they were very early to flower.

The Chester County Yellow Dent gave a better yield, but was still not so good as the Station bulk.

As reported last year, the main use we have for these yellow maize stocks is for crossing, and it is the yielding power of their derivatives which will be of interest.

Ground-nuts.—This crop also did well, in spite of a slow start and, in certain fields, poor stands. The mean yield for 20 acres of Gambia bulk was 1,360 lb., nuts in shell, per acre. Our collection of varieties was maintained in small bulk, but no further re-selection work was done.

The possibility that this crop is somewhat exhaustive of soil fertility, or else has some specific effect on cotton or on itself, when cotton or ground-nuts follow ground-nuts, is causing some concern.

For the present it is confined to one break of the main rotation, and is therefore only grown once in eight years in any given field.

Pigeon Peas.—Once again fair to good stands were obtained with this crop, but as an insurance, a light inter-planting of elephant grass is being included in the rest-cropping areas.

Pigeon peas die out to a considerable degree in their third year when, at Domira Bay, their cover is replaced by weeds and grasses.

Elephant grass will now augment this third year cover, since in addition to its vegetative spread it also seeds freely in Nyasaland. Quite a high proportion of the seed set is viable.

Elephant Grass.—The new experiment to compare elephant grass in pure stand and an elephant grass/velvet bean mixture was planted successfully, and the plots will remain for at least two years. After clearing, they will be planted to cotton for study of treatment effects.

The velvet beans swamped the grass to some extent, but did not affect the stand unduly. After they had ripened off, the grass grew more quickly. Though some seed has been harvested, for the most part the beans are being left to self-seed naturally.

The elephant grass spacing experiment was left, and still maintains its excellent cover. It will probably be uprooted in the 1943 dry weather.

Miscellaneous Crops.—As usual a range of these were grown in odd areas on the Station, and Nzama (*Voiandzeeia subterranea*) was

tried out as an inter-crop in maize. It was not very successful so grown and the experiment will not be repeated.

Soya beans gave very poor stands, and some new seed stocks, obtained from the Agricultural Officer at Ncheu, will be tried next year.

A new citrus nursery was established and several hundred buddings on rough lemon stock with good varieties of oranges, grape fruit, naartjes, etc., were made. It is intended to plant a new orchard at No. 2 borehole, from which to provide a regular citrus ration for the Station labour force.

Genetics and Breeding.

The small bulk trial referred to above contained twenty-five selections from Crown Land commercial U.4 bulk, local "920," Mz.561, and the special bulk of "561" selected in 1941. All these cottons had been sent to England for spinning and hair tests, and figures on all except the "561" lots were available before harvest. The Mz.561 lint was unfortunately lost in transit, as was that of N.17. The duplicates also went astray.

The spinning tests showed that twelve out of the twenty-five C.L. selections were as good or better than "920," and it was decided that this U.4 strain should prove a *minimum* basis for lint as well as for yield comparisons.

The trial was planted partly on black soil and partly on red soil, and provided a good comparison. As with the Standard strain trial, the following summary is based on "920"=100.

Mz.561 S.B.	144	
C.L. 72	136	
C.L.177	129	
Mz. 561	128	
C.L.119	119	Significant Differences
C.L. 85	117	
C.L. 20	116	27 P=0·01
C.L. 68	116	20 P=0·05
C.L. 93	112	
C.L.123	111	
C.L.165	108	
Local "920" Bulk	100	

The C.L. lots shown in this comparison all spun well and will be planted in 1942/43, but none of the twenty-five will be discarded till spinning tests have been made on material from the small bulk trial. This material, which has already left for England, should provide really reliable comparisons.

One strain, C.L.20, was of particular interest. In addition to being very jassid-resistant and a fairly good cropper, it gave much better hair test figures than is usual with U.4 types from Nyasaland. The remainder of the C.L. lots which it is intended to plant in 1942/43 were more usual in their characters, but all gave lower standard hair weights and higher standard counts (by formula) than the "920" types sent for comparison.

It is hoped that Mz.561 lint will this year reach England safely from Nyasaland since on the reports we receive on this cotton much will depend.

Not only has it done well at Domira Bay in a difficult season, but also at two places in the Lower River area including the Makanga Station.

The seventy-two single plant selections taken from " 561 " special bulk last year were planted in progeny rows and vigorously rogued for jassid susceptibility. Those retained have been subjected to further elimination on ginning out-turn, in an attempt to find a better ginner than the parent bulk. It has yet to be seen if a satisfactory ginning out-turn can be obtained without sacrifice of other desirable characters.

The sixty-eight selections from N.17 were subjected to a similar process and their survivors will be planted in 1942–43. A special bulk of this variety is being retained so that valuable characters may not be lost by possible mistakes in the re-selection process.

By courtesy of Mr. Peat, seed lots of Ukerewe Local, Ukerewe Ilangala, and 561/6 were obtained from Tanganyika. They were sown in observation plots and all did well. The plots were well rogued for jassid susceptibles, and harvested as bulk for further study. Lint samples from all three have been sent to England. As with " 561 " the ginning out-turns of all three of these Tanganyika cottons were low on Nyasaland standards.

Reference has been made above to the satisfactory performance of " 920 " in commercial plantings. This and its sub-strains are being maintained in small bulk at Domira Bay, both in natural and selfing plots, but it is not intended to do further re-selection work on them for the present.

The U.4 × Cambodia × U.4 cross, N.C., made at Domira Bay, was given a particularly good mark in the spinning tests, where it, or rather three sub-strains, were reported to be the least neppy of all the samples. Mr. Prentice reports that N.C.4 did well in a strain trial at Shinyanga, Tanganyika, this year.

Resumption of work with this cross may be indicated if the U.4 " 920 " style of lint quality is to be retained, but it is hoped that a more valuable cotton, with satisfactory agricultural characters, may be found in either the Crown Land selections or the Tanganyika " Uplands."

Mr. J. B. Hutchinson has kindly supplied the Station with a range of *G. religiosum* varieties, with which it may be possible usefully to increase the range of variation in our breeding material. These cottons will be planted on an irrigable site next season.

Makanga Sub-Station, Chiromo.—This Station, as in 1940/41, was devoted primarily to the needs of the Insect Pest Control Section, and will be dealt with in their report.

A standard strain trial was successfully concluded and results were received from Mr. Pearson while this Report was being written.

As a matter of interest, these results are compared on the same basis as the two Domira Bay trials, *i.e.*, " 920 "=100.

Crown Land U.4 Mixture	152	Significant Difference 26 P=0·05
Mz.561	132	
Local " 920 "	100	

Only the varieties common to both stations are given above, and it will be noted that whereas Mz.561 maintains the same relative position in regard to " 920," Crown Land U.4 is ahead of " 561," though not by a significant margin ; both are better than " 920." This is the third year in succession that Crown Land U.4 has headed the variety trial at Chiromo, and some trials with the new Crown Land selections will be very interesting.

When the Insect Pest Control work has stabilised yields at Makanga some local selection work may prove fruitful.

Summary and Conclusions.

A somewhat difficult year, made so by the type of rainfall distribution, has been experienced at Domira Bay. But work on agricultural problems connected with cotton has progressed satisfactorily.

It has been decided to increase the " rest " years in the main rotation to three, and the rotation itself to an eight-course.

The way in which rest cropping should be done is being increasingly studied, and several new lines of attack are being developed on the African's time factor problem.

Ground-nuts, an important secondary crop for food and cash, may provide some problems peculiarly their own in relation to cotton, but no definite statement can yet be made.

Work with the " 920 " strain of U.4 has been carried to the large-scale commercial stage in the S.W. lake shore section of the Central areas, but on the Station will now be abandoned in favour of work on the selections which have been made from Crown Land Bulk U.4 mixture, and on various East African Uplands, especially certain cottons from Tanganyika.

It is unlikely that " 920 " will prove superior to the existing commercial cotton in the Lower River area, where the latter, in spite of faults arising from its mixed origin, is still a very valuable strain, capable of high yields and of producing fair quality lint which is easily saleable.

The close season measures for the control of pests were a success for the fifth year in succession at Domira Bay.

PROGRAMME OF EXPERIMENTS, 1942-43 SEASON.

Cotton.

Standard Strain Trials.—The experiment carried out in co-operation with Barberton will be repeated, with new seed supplied by each station. The number of " 920 " derivatives will, however, be reduced to three and certain other varieties added in their place.

The best of the Crown Land Selections, and certain of the East African Uplands, will be compared in a second trial. Crown Land Bulk U.4 mixture will be planted in each trial.

Small Bulk Trials.—It is not intended to plant a small bulk trial next season.

Increase Plots.—The best of the Crown Land Selections, and of the East African Uplands, will be multiplied for further trial.

Breeding Plots.—Selfed stock of all leading strains and varieties will be grown, and the surviving selections from Mz.561 and N.17 grown in progeny lots. Re-selection within several of the Crown Land selections may be begun.

Rotation Crops and Experiments.

The residual effects of the large-scale rotation experiment on maize will be studied. Native bulk-selected maize will be sown on all plots at standard spacing.

The crossing work with the Yellow maize stocks will be continued and a mass selection of cross-bred material multiplied.

All the old, and a number of new experiments with the main rotation and rest crops, will be carried out. The cotton/ground-nut relation will be a special study.

Any special work requested by the Insect Pest Control Section will be done, as in previous years.

ENTOMOLOGICAL WORK.

PROGRESS REPORT, 1941-42

BY

E. O. PEARSON AND B. L. MITCHELL.

General, and Lower River Districts (E. O. Pearson).

General.—The general plan of research has been followed whereby Mr. Mitchell maintains a limited amount of routine recording in the Lake Shore area, but concentrates largely on experimental work on the diapause problem of Red bollworm at the Domira Bay Station, whilst the writer has charge of the recording and experimental work in the Lower River itself. The details of the latter work were the same as last year and need not be repeated.

Owing to the necessity for writing this report some time before the cotton season and the associated recording work in the Lower River have been completed, it is only possible to give rough indications of the season's results and the probable interpretations of them.

Weather Conditions.—The season has again been a dry one, the total rainfall being about 75% of normal and concentrated in the early part of the season. There were fair rains in early November, but these were succeeded by a month of dry, hot weather; December–February rains were good, on the whole, but the March–April rainfall was again low (37% of normal) and the cool season rainfall, though better than last year, was too small to have much effect on crops after the March–May drought.

The Shire River continues to maintain a high level, without violent fluctuations, but as a result of two dry years some flood land is now becoming available in the latter half of the dry season and is being used mainly for maize and sweet potato plantings.

Crop Statistics.—The great bulk of the maize and millet crops were planted in the first half of November. The former suffered from the hot, dry weather which followed planting and stands were often very poor: this had a marked effect on the inter-planted cotton, which in many cases approximated to pure stand.

In the last two years a census has been made annually, in each of the seven or eight districts where we are working, of a small, compact area in which the crop history and size of all native gardens have been recorded. The results are of some interest as showing the position of cotton in the native economy. It should be pointed out that only maize, millet and cotton gardens have been dealt with in these censuses: sorghum has been omitted, since this is never inter-planted with cotton. It accounts for a considerable proportion of the total area in the Lower Shire district only where, on the sandy soils around Port Herald, it replaces maize to a great extent. Elsewhere in the Lower River maize and millet constitute the immense majority of the gardens.

TABLE I.

DISTRIBUTION OF CROPPING IN NATIVE GARDENS IN 8 SAMPLE AREAS, 1941-42.

		Percentage of gardens planted in :				
		Maize	*Millet*	*Pure Stand*	*Total*	*No. of gardens analysed*
Inter-planted with cotton	1941 ...	39·6	19·9	3·5	63·0	
	1942 ...	39·0	18·7	0·7	58·4	
No cotton	1941 ...	17·9	19·1	—	37·0	
	1942 ...	15·9	25·7	—	41·6	
Total	1941 ...	57·5	39·0	3·5	100·0	1,374
	1942 ...	54·9	44·4	0·7	100·0	1,833

It will be seen that practically the whole of the cotton crop is inter-planted and that about two-thirds of the cotton gardens are in maize and one-third in millet. The actual *acreage* under the two crops is not quite in this proportion, since the maize gardens are nearly twice as large as those of millet (1·94 acres against 1·03 acres respectively). Taking this into consideration, the relative acreage inter-planted to maize and millet is about 3·8 to 1.

The great bulk of the cotton crop was planted in the last 2–3 weeks of January, but there were a limited number of very early plantings in the last few days of December. Taking it as a whole, the crop was about a fortnight earlier than in 1941. Goods stands were obtained and growing conditions in the early stages were excellent.

The statistics of the Department of Agriculture show that there was an increase of nearly 50% in the number of cotton gardens over last year (27,596 against 18,577) ; moreover, taking into account the fact that last year only some 59% were estimated to become sufficiently well established to contribute anything to the crop, the *effective* acreage this year was nearly $2\frac{1}{2}$ times that of 1941. The final production figures showed that the crop reached a total of 5,195 tons of seed cotton, *i.e.*, more than four times the crop of 1941 ; 93·5% of it was No. 1 grade.

The weekly pickings from the sample gardens used for recording give an average yield of nearly 400 lb. per acre of seed cotton, of which 91% is No. 1—just about double the yield of 1941.

Crop Production and Crop Loss.—The figures for crop production and crop loss, based on analyses of weekly sample pickings, are not complete, but the figures to date (which include probably 90% of the crop) show that of those bolls which neither shed nor aborted in the first two weeks of their life, 38% were a total loss to bollworm, 7% to staining and stainer damage, and 3% to other causes, 52% contributing clean cotton. These figures are similar to those obtained last year (30% bollworm, 9% stainer, 3% various, 58% clean), but as the gross boll production is nearly double, the actual volume of damage and also the actual production of clean bolls are correspondingly higher.

Crop development this year was similar to 1941, that is, the whole of the crop was set before the cool season. The earlier planting, the

diminished competition of the inter-cropped maize due to earlier maturity and poor stands, the good early growing conditions and the sudden cessation of the rains in March followed by hot, dry weather, all favoured rapid early growth and the production of a flowering curve rising steeply to a peak of intense production in April and abruptly descending in May. The successful maturation of a large proportion of the bolls from the early flowering and the consequent early onset of senescence, coinciding with increasingly dry conditions, contributed to this sudden cessation of flowering. Growth had, in fact, virtually ceased by the end of April and, over the Lower River as a whole, almost the whole of the crop had opened by the end of June.

The only instances in which this course of events was not followed were in the Port Herald section of the Lower River, where the greater part of the crop is inter-planted in millet, which has a much stronger retarding effect on the cotton than has maize. This holding back of the crop, coupled with a relatively heavy bollworm attack, led to the bolls being stripped before reaching any size and hence no onset of senescence, and prolonged, but inefficient, budding and flowering.

Bollworm Activity.—The same general phases of bollworm activity have been recognisable this year as in the preceding two, but the course of this activity has more closely resembled that of 1940 than that of last year, the egg-laying in the second phase (May–June) being considerably greater than that in the first phase (February–April).

It was remarked in our last report that, owing to the diminished 5th instar population in the latter part of 1941, the carry-over of diapause pupæ and the consequent size of the initial moth flight in 1942 should be much reduced. This was in fact the case, egg-laying per acre being about half that in the corresponding phase last year. Two circumstances, however, prevent us from claiming that this reduction is wholly in accordance with our forecast ; first, because the increase in acreage in 1942 would of itself (other things being equal) be capable of producing the diminution in intensity of egg-laying noted ; secondly, because the contributions of the May–July 5th instar populations to the diapause fraction of the pupal population were much larger in 1941 than they had been in 1940.

There are three factors which affect the intensity of the egg-laying and the resultant crop loss due to the diapause moth flight :

(i) The acreage in the season under review relative to that of the previous year. Obviously an increase in acreage will dilute the infestation and a decrease will concentrate it.

(ii) The size and timing of the diapause moth flight. The size of the diapause flight depends on the pupal populations existing the previous season and on the proportion of those populations entering the diapause. The timing of the flight depends, of course, on the time of break up of the diapause.

(iii) The state of the crop at the time of the diapause moth flight. This has a direct effect, it is thought, on the number of

eggs laid per moth and is also, of course, of first importance in determining the amount of damage to the crop, which depends on the extent to which boll production does *not* synchronise with maximum moth activity.

Unfortunately, in the 1942 season all these factors worked in combination in the different districts in such a way as completely to confound their separate effects :—

Chikwawa.—Very large increase in acreage (increase over 1941, 80·6%). Small diapause moth flight, peak of which occurred very late (April). Crop production early and abundant. Result : Very little bollworm damage and a large, clean, early crop.

Chiromo-Mlolo.—Large increase in acreage (increase over 1941, 43·4%). Diapause moth flight normal, peak March. Crop production early and abundant. Result : Moderate bollworm damage and fairly large, clean, early crop.

Port Herald.—Small increase in acreage (increase over 1941, 19·1%). Diapause moth flight fairly large, due to large larval populations late last season, normally distributed. Crop production late, due to high proportion inter-planted in millet. Result : Relatively heavy bollworm damage and early crop small.

The numerical effects on the crops in these areas is shown in the table below (the figures being incomplete).

TABLE II.

NUMBER OF BOLLS (IN THOUSANDS PER ACRE) PRODUCED OR LOST OVER THE MAIN CROP PERIOD, 1942.

	Bollworm	*Other Causes*	*Clean*	*Total*
Chikwawa	172·5	60·0	524·5	757·0
Chiromo-Mlolo	337·0	49·5	432·5	819·0
Port Herald	326·0	135·5	200·0	661·5

The heavy bud and flower production early in the season must be regarded as due partly to the vigour and earliness of the crop and partly to the relatively light first phase of bollworm attack. A big crop of bolls was thus established, part of which developed mainly during the first phase of bollworm activity and was thus very little damaged. This first phase of bollworm activity developed under very favourable conditions and, in contrast to 1941, a very much bigger second phase resulted, approximating to that of 1940. Even so, the crop which was by then established was so large that, in spite of very considerable losses to bollworm, a handsome balance—by Lower River standards—survived as clean cotton.

The larval populations in this second phase were big and, taking into account the large acreage over which they were produced, the carry-over of diapause pupæ to 1943 may, it is feared, be large, especially if the proportion of diapause pupæ amongst the populations derived from this phase is as high this year as it was last.

Stainer Infestation and Damage.—Stainer infestations, although on a bigger scale than in 1941, did not develop until after the bulk of the crop had passed its susceptible stage and as a result stainer

damage was relatively slight, only amounting to a loss of 7% of the crop, as compared with 9% in 1941 and 30% in 1940.

The initial immigration of *D. intermedius* started, as usual, in late April–early May and reached a peak population at the end of May or early June. This peak nowhere exceeded 500 adults per acre. In some cases fairly considerable populations of 5th instar nymphs were matured (up to 2,500 per acre) in mid-July, but owing to the usual dispersal on reaching maturity, the adult populations so formed rarely equalled the initial infestations and by mid-August the species had practically disappeared from the cotton gardens.

In the case of *D. fasciatus* the initial infestations occurred at about the same time as those of the other species, but were not as large. However, breeding was continuous and by August populations of the order of 1,000 to 3,000 adults per acre had been built up, with correspondingly large populations of 5th instar nymphs.

Evidence over the past three years regarding stainer breeding in the Lower River crop has been somewhat conflicting: breeding is undoubtedly very often restricted in the cool season, but the proof of whether this is due to food shortage, low temperatures, or low humidity, or combinations of these factors, awaits a critical analysis which has not been completed. As regards the bearing of this on damage to the crop, however, it seems clear that a really early crop, such as we had this year, will evade the greater part of the stainer attack in the same way as do rain-grown crops on the Lake Shore and in Southern Africa generally, merely in virtue of the fact that the initial immigration, which is not a big one, has no time to build up a really large infestation before the bulk of the crop has passed the susceptible stage. Where an exclusively late crop (*i.e.*, one maturing its bolls in the hot dry season) occurs, it may also evade a good deal of stainer damage, since lack of food, plus the climatic factor, appears to prevent the building up of a large stainer population during June–July. Where, however, a combination of the two types of cropping occurs, as in the case where the first crop is partly lost to bollworm and the plant continues to produce bolls over a very long period, continuous breeding can apparently occur and the later crop may be very heavily damaged. This happened in the Port Herald area this year, as the following table clearly shows. The switch over from bollworm loss to stainer loss is especially interesting.

TABLE III.

MONTHLY CROP PRODUCTION AND CROP LOSS IN THE PORT HERALD AREA, LOWER RIVER, 1942.

Month of Harvesting	*Number of bolls (in thousands per acre) produced or lost, followed by percentage of monthly total in brackets.*			
	Bollworm	*Stainer*	*Clean*	*Total*
May	78·9 (75·6)	1·5 (1·4)	23·3 (22·3)	104·3
June	177·5 (54·9)	24·7 (7·6)	118·7 (36·7)	323·7
July	76·1 (40·6)	45·6 (24·3)	62·7 (33·5)	187·5
August	64·1 (39·5)	69·9 (43·1)	27·9 (17·2)	162·3
September (first 2 weeks)	30·1 (23·5)	72·4 (56·5)	24·7 (19·3)	128·1

Time of Planting Experiments, Chiromo Sub-Station.—The main experiment is still in progress and results have not been completed.

In both this and the preceding year there has been no significant difference in yields from early, mid- and late January plantings, intercropped with maize ; this year pure stand planting as late as mid-February gave similar yields. All later plantings have been much inferior. It must be remembered, however, that both these years have been unusually favourable to early planting and unusually severe on late plantings.

In the same way, in an experiment in which early, medium and late plantings of cotton were tested with early, medium and late plantings of maize, in all combinations, there was no significant difference in the yield of cotton planted in mid- or late January, although the mid-February planting was much inferior. It is interesting to note, also, that the highest yields of cotton came from the earliest planting of maize (Nov. 9), which in turn gave the highest yields of maize. Cotton planted in December-planted maize (both mid- and late December) gave very much lower yields, irrespective of the date of planting of the cotton itself.

Pupation Work, Red Bollworm.—Pupation records from cages embedded at three sites have been continued and have yielded a wealth of information. It was pointed out in last year's report that this information, coupled with the field survey, enables us to calculate the form, dimensions and origin of the seasonal moth flight, particularly that part of it which constitutes the initial infestation of the new crop—what we loosely term the " diapause flight." Such diapause flight curves were constructed for all three of the observational areas of the Lower River last season (1941–42) for the first time, and gave generally good agreement with the observed infestation, as estimated by egg counts and crop loss.

The course of emergence was broadly similar in all areas to that observed in previous years at the Chiromo Sub-Station.

TABLE IV.

CALCULATED NUMBERS OF MOTHS OF THE DIAPAUSE FLIGHT EMERGING PER ACRE AT DIFFERENT STATIONS, LOWER RIVER, 1942.

Station	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mar.*	*April*	*May*	*June*	*Total, Dec.–June*
Chikwawa	13	73	13	11	60	315	71	0	543
Chiromo-Mlolo ...	91	322	138	484	1,190	535	139	12	2,820
Port Herald	32	232	52	140	416	354	50	0	1,244

It will be seen that all stations show the same bimodal flight curve, with the first peak in December and the second in March or April. Note also the delay in the emergence at Chikwawa, which permitted the establishment of practically the whole of the earliest-formed bolls in that area.

It was pointed out last year that these data provide us with a powerful method of calculating the planting dates best suited to avoid the diapause flight. The following table shows what proportion of the diapause flight would have been evaded by planting at different dates this season. The assumption involved in constructing this table is that no food is available for bollworm larvæ until 6 weeks after the date of planting.

TABLE V.

PERCENTAGE OF TOTAL DIAPAUSE FLIGHT EVADED BY DIFFERENT DATES OF PLANTING, 1942.

Date of Planting	District		
	Chikwawa	*Chiromo-Mlolo*	*Port Herald*
6 December	15·8	14·6	21·4
3 January	16·7	20·1	23·7
17 January	16·9	26·8	29·7
31 January	19·5	44·2	41·8
14 February	22·6	67·7	60·3
28 February	38·9	83·2	79·6

Clearly, with emergence of the type noted this year at Chikwawa, it is useless to attempt to avoid any considerable proportion of the diapause flight by delayed planting. On the other hand, at Chiromo and Port Herald, although little advantage is gained by delaying planting within the period December to mid-January, *after* that date very substantial benefits accrue.

It was also pointed out last year that by eliminating the pupæ originating late in the season, which appeared to have the greatest tendency towards diapause, a reduction in the size of the diapause moth flight could be obtained. This statement was qualified by the proviso that if cotton were planted early enough to mature its crop before the cool season and were cut out at the end of July, thus eliminating the August–October derived portion of the diapause moth flight, there would be a possibility that the May–July pupal contributions to this flight would be very greatly increased. The 1941/42 carry-over unfortunately somewhat supported this fear: the 1941 season was, in effect, just such a one as was envisaged, the whole crop maturing by the end of July, and May–July yielded a noticeably larger proportion of diapause pupæ than was the case in the previous year.

TABLE VI.

NUMBER OF EMERGENCES AS DIAPAUSE MOTHS AS PERCENTAGE OF TOTAL EMERGENCES FROM PUPÆ FORMED EACH MONTH, 1940/41 AND 1941/42.

	Month of Origin of Pupæ					
	April	*May*	*June*	*July*	*August*	*Sept.-Oct.*
Pupæ formed 1940, emerging Dec., 1940–June, 1941	?	8·5	7·6	27·7	56·5	72·2
Pupæ formed 1941, emerging Dec., 1941–June, 1942	18·1	38·8	40·3	27·7	44·6	45·4

It is possible that some of the discrepancy between the two years is due to a heavier mortality amongst potential diapause pupæ in 1940: the total survival amongst the experimental pupæ in May–June of this year was 49·2%, whilst among the experimental pupæ in the same months in 1941 it was 72·1%. Were the whole of this difference to be due to unnatural mortality (*e.g.* accidental entry of ant predators, etc.) exclusively amongst the potential diapause pupæ, then the true percentage of diapause emergences might have been as high as 31% in 1940/41. Even so, this is still a lower figure than that for this season and the assumptions made in obtaining it are very big ones, though not entirely unwarranted.

The matter is one of great importance, since one of the main arguments in favour of early planting and a pre-cool season crop as

a means of bollworm control is that the main production of diapause pupæ would thus be eliminated. If the 1941 season is typical of such a cropping system, clearly this argument loses a great deal of force. Against this, it must be admitted that the 1940 weather was more typical of the Lower River climatic conditions, and if it is these conditions, and not food supply, which primarily influence the induction of diapause, then the high carry-over of May–July pupæ in 1941–42 may well have been merely the result of very abnormal weather conditions. The whole question awaits a solution of the diapause problem.

Pupal Mortality.—As briefly reported last year, an investigation was started in 1941 on the mortality occurring under natural conditions amongst Red bollworm pre-pupæ and pupæ. Pre-pupæ and pupæ were studied separately. In the case of pre-pupæ, single 5th instar larvæ feeding in bolls were confined in the above-ground portion of cylinders of perforated zinc, open at the bottom and inserted 4 inches into the soil, and closed at the top by wire gauze lids. The perforations were of such a size as to permit the entry of insect predators whilst preventing the escape of the larva. Unfortunately, it so happens that the head capsule of the 5th instar bollworm is of the same order of size as the smallest hole which can be negotiated by the commonest predator—the ant *Myrmicaria eumenoides* Gerst.*—and hence a compromise was necessary by which holes were made of such a size that an occasional larva may escape whilst a proportion of the larger predators are excluded from entry above ground.

Pupæ, freshly formed under protected conditions, were studied simply by burying the earthen cell 1½ inches below the soil surface and marking the spot with a metal label. Duplicate series were exposed, one being lifted weekly and examined for emergence or cause of death, the other being exhumed at long intervals only as a check on the handling effects in the first series.

Insertions of 50 individuals of each treatment were repeated at weekly intervals throughout the season (April–October inclusive), at the rate of one individual of each treatment in each of 50 blocks occupying approximately an acre of cotton all told. This arrangement and density was adopted in order to simulate the normal density of occurrence of pupæ in the field and thus avoid upsetting the host/predator ratio. The observations were duplicated at the Chiromo Sub-Station and at the Domira Bay Station. The results obtained at the latter station are reported by Mr. Mitchell : they differ rather widely from those on the Lower River, mainly in the high losses due to rodents, which were not remarkable at Chiromo.

Over the whole year, 68% of the larvæ inserted on the Lower River successfully pupated and 51% of the pupæ so formed eventually emerged, the total survival from 5th instar larva to adult moth thus being approximately 35%.

* Kindly identified by Capt. C. Smee.

Amongst larvæ and pre-pupæ, losses due to complete disappearance of the larvæ averaged 22%, but this is thought mainly to be a reflection of the extent to which escapes occurred. Fates of pre-pupæ and pupæ over the whole season, expressed as percentages (in the case of pre-pupæ as percentages of those not escaping) are given in the following tables.

TABLE VII.

Percentage Mortality Amongst Larvæ and Pre-Pupæ Due to Various Causes, 1941/42.†

		%
Before forming cell :	Larvæ eaten	17·1
	Larvæ dead	6·4
After forming cell :	Larvæ or pupæ eaten	4·5
	Larvæ or pupæ dead	3·6
Successfully pupated		68·4

TABLE VIIa.

Percentage Mortality Amongst Pupæ Due to Various Causes, 1941/42.

	Pupæ examined weekly (*B*)	*Pupæ examined at long intervals* (*C*)
	%	%
Missing or removed (by predators or accidentally)	4·9	12·4
Eaten by predators	20·7	20·9
Dried up or moulded	29·9	15·3
Successfully emerged	44·5	51·4

Amongst pre-pupæ, there is little seasonal trend in survival until the hot dry season (late Sept.–Oct.), when mortality from all causes tends to rise. Amongst pupæ, there are certain differences between the weekly examinations and the long term ones to be noted.

The difference in the numbers missing and removed is mainly an artifact, due to the exposure of treatment C pupæ to the chance of loss over longer periods. The main difference lies in an excess of deaths due to desiccation or moulding amongst treatment B pupæ, and it is significant that this excess mortality occurs wholly during the hot dry season. Concurrently, there is a deficit of diapause pupæ in treatment B. These facts suggest that handling has the effect of increasing natural mortality at the expense of diapause pupæ, by exposing them more frequently to desiccation.

There is not much difference in the mortality due to different causes, and hence in survival, between pupæ originating in different months from May to July inclusive. Pupæ originating in September–October, however, show a sharp rise in mortality from predators, desiccation and moulding. August-derived pupæ are intermediate.

As regards the time at which mortality occurs, up to November practically no deaths due to desiccation occur. The seasonal distributions of deaths due to desiccation and to moulding are identical, suggesting that moulding is not especially correlated with wet weather, but is a secondary, possibly post-mortem, effect.

† This represents losses from the time of insertion of 5th instar larvæ into the cages up to the lifting of the cages 9 days later.

A general inspection of the record suggests that death from all the various causes occurs at about the same time as emergence does, *i.e.*, that the pupæ only become susceptible to lethal factors when they start to develop. This can be statistically established in the case of death from predators, but not in the case of desiccation.

A further fact of considerable interest which has been established is that the various lethal factors appear to act impartially upon both young and old diapause pupæ, *i.e.*, that pupæ do not become more, or less, resistant with age to the various fates which befall them in the hot dry season and the rains. Pupæ which are recently formed and those which have been in diapause for five months, appear to be equally susceptible to the attacks of predators, to desiccation and to mould. There is also some suggestion that they are all equally susceptible to the factors breaking up diapause.

Stainer Breeding.—An immense amount of data has been accumulated on the reproductive and mortality rates amongst all stages of *Dysdercus intermedius* Dist. and *D. fasciatus* Sign. under various conditions on the Lower River. Much of this still awaits analysis, but the results with incubation of eggs and the development of 1st instar nymphs from July, 1941, to May, 1942, are available.

Egg batches have been exposed weekly to a wide range of semi-natural conditions obtained within small cylinders of wire gauze which can be inserted into long tubes of perforated metal permanently embedded in the soil. The treatments used were :—

A. 1½ inches below the surface of a permanent bare fallow.
B. The same, but 3 inches below.
C. 1½ inches below the surface of shaded soil in a grass plot.
D. The same, but 3 inches below.
G. 100% R.H. in a grass-roofed insectary, the temperature approximating to that in the standard screen.
H. Atmospheric conditions in the same insectary.

In treatment A, where the maximum temperature was never less than 36°C., no hatching occurred at all. In treatment B, no hatching occurred either, save on the few occasions when the maximum temperature fell below 34·5°C. In the remaining treatments hatching was determined mainly by the maximum temperature ; when this rose above 34·5°C., hatching ceased. This agrees pretty well with the upper lethal limit previously determined by laboratory experiment (Pearson, E.C.G.C. Rpts. from Exp. Stations, 1937–38, p. 49).

In treatment G, where temperature was the only variable, no hatching at all occurred between mid-September and mid-December when the main rains broke. Thereafter hatching occurred regularly, though with variable success, right through the season. In all cases where hatching took place the nymphs also successfully developed to the 2nd instar.

Treatments C and D behaved somewhat similarly as regards hatching of eggs, although this was extremely sensitive to rainfall,

mainly through the effect of this upon soil temperature. The 1st instar nymphs so formed, however, were only able to develop when soil moisture conditions were good (*i.e.*, in the main rains and the early part of the cool, dry season). From July to November, and during hot, dry spells in December and January, no 1st instar nymphs survived in these treatments.

Treatment H proved the most rigorous of all; there was no hatching at all except in the main rains, and only on very few occasions, during especially protracted wet weather, did any 1st instars succeed in moulting.

Treatment A has now been abandoned after a full year's records. Instead, a site is being used below soil debris in a dense thicket surrounding the base of one of the common wild host trees, *Sterculia appendiculata* K. Sch. This represents the most favourable site for egg development which is likely to occur naturally.

These results are only preliminary; the data for the cool season are not yet worked out and it is impossible to say whether the inhibiting effect of low temperatures in the cool season is as great as it is believed to be, or whether the effects of low humidity on the 1st instar nymphs is more important.

Lake Shore Area (B. L. Mitchell).

At the time when the 1941 Report was written, much of the experimental work described therein was not complete since it concerned the long-term pupation of the Red bollworm (*Diparopsis castanea*, Hmps.). The work was not completed until six months after the Report was due. A similar state of affairs exists with most of the work carried out this year, which cannot be fully reported until 1943. For the sake of clarity a certain amount of repetition of what was written twelve months ago is necessary.

The effects of different humidities on the length of pupal life.—The humidity chambers used were 1½ litre bottling jars with ground glass tops. Since the Domira Bay Station is not provided with a constant temperature room, the experiments had to be run in the insectary where, of course, the humidities fluctuated during the course of the day around a mean. The humidities, therefore, must not be regarded as constant, but they varied sufficiently one from another to show up any crude differences in behaviour which could, if necessary, be studied more accurately at a more fully equipped station. The humidities chosen were 100% over distilled water and 75% and 50% over glycerine solutions. In this experiment nearly 700 moths have emerged in each humidity and it can definitely be stated that there is no difference in the behaviour of pupæ under these various conditions. Eight pupæ still remain alive after sixteen months.

Comparison of pupæ within and without their earthen cells.—Long series of freshly formed pupæ were divided at random into three treatments—in their unbroken cocoons, shelled from their cocoons, and shelled from their cocoons but blanketed in half an inch of loose soil. Contrary to what was suggested in the 1941 Report, there is no difference in the behaviour of short-term individuals in the different treatments. Subsequent to the emergence of the short termers, however, there is considerable difference in behaviour. During the four to five months between the end of the short-term emergence and late October only about 7% of those in their cells emerge, there being a very definite diapause. Between 50% and 80% of naked pupæ, however, emerge during this period, the curves suggesting continuous emergence. Those pupæ which were blanketed in soil emerged in a manner intermediate between the others. This behaviour is of great importance for the technique to be adopted in future laboratory experiments on pupation. Naked pupæ are very much more convenient to handle since they occupy far less space and their state of development is readily observable, whilst with those in their cocoons it is not always possible even to determine whether they are still alive. Unless the behaviour of the two groups can be standardised, it would not always be safe to use naked pupæ for experimental work. During 1942 two separate experiments totalling 800 pupæ in each treatment are being run under controlled temperature conditions in an incubator. Emergence is now complete in the first experiment showing that the behaviour of naked pupæ is identical with that of pupæ within their cocoons when kept under constant temperature conditions. It may therefore be considered safe to use naked pupæ for laboratory experiments provided that such experiments are carried out in an incubator. It is now apparent that red bollworm pupæ are very sensitive to temperature and that their reactions to various temperature conditions are exceedingly complex.

The effect of short submergences on the break up of diapause.—A large number of pupæ that had over-wintered under uniform field conditions were randomised into seven treatments and subjected to various numbers of 3-day submergences under water during the hot season of September to November. Between submergences they were replaced under field conditions. No development was stimulated prior to the break of the rains. During the normal course of diapause emergence on the Lake Shore there is a trough in the emergence curve towards the end of January when the emergence of moths temporarily ceases, dividing the moths from the diapausing pupæ into two groups, the first of which incidentally are flying before the cotton has started bud production and therefore all die without being able to lay their eggs. In 1942 this trough occurred during the week ending 24th January. Examination of the results of this submergence experiment show that those groups which received the greatest number of submergences during the hot weather tended to emerge before the January trough, whilst those which received few or no submergences tended to emerge after the January trough. This was significant to the χ-squared test

when P=0·01. Since it has been shown that diapausing pupæ are unable to absorb water and gain in weight during submergence and that submergence as such does not affect pupæ, this may be taken as further evidence that the long-term pupal diapause is caused by long periods of high temperature and that the effect is cumulative. Should this ultimately prove correct, it will follow that any treatment which tends to reduce soil temperatures during the hot months of the year would be a very useful control measure since it would bias the emergence of diapause moths in favour of the December–January phase which can do no damage to the following crop. This is being anticipated in a field experiment this year. It is believed that a dug soil is cooler than a compacted one. Just prior to the break of the rains pupæ will be collected from dug and undug soils in as large numbers as possible. These will be inserted in standardised conditions in the pupation cages and the emergence recorded.

Pupal mortality under field conditions.—This experiment was designed in order to ascertain what becomes of red bollworm larvæ when entering the soil to pupate and also of the pupæ when lying in the soil throughout their natural lives. The insects were exposed as much as possible under natural conditions in order that predators should take their normal toll. A certain amount of confinement was necessary for the 5th instar larvæ since their instinct in seeking out suitable pupation sites causes them to be very restless. Larvæ were consequently confined in small bottomless perforated zinc cylinders half sunk in the ground and covered with mosquito gauze lids in which extra perforations were made to allow ants and other small predators to enter. Fifty full fed larvæ were distributed weekly for twelve weeks over an acre of cotton field during that part of the season in which they were available. The accessibility of the cages to predators resulted in a number of escapes and it is not possible to differentiate between escapes and complete removal by other agents and to decide which of the two fates accounted for 25·8% of the whole. 4·8% died as larvæ, 2·8% were eaten by insect predators as newly formed pupæ, 1·2% died from unknown causes, and 65·4% pupated successfully. The proportions did not vary significantly throughout the season. If all the individuals unaccounted for were escapes, then the proportion pupating successfully would be raised to a maximum of 87·4%.

Pupæ were simply planted $1\frac{1}{2}$ inches below the surface of the soil at the foot of a small metal label and were, therefore, completely exposed to attack from above or below ground. The acre field was divided into 50 plots. Two independent series of pupæ were inserted each week, one for examination weekly, the other for examination at longer intervals. The course of mortality and emergence was identical in these two series showing that the handling had no effects upon the pupæ. Of those pupæ which emerged or died prior to the uprooting of the cotton in July, 45·6% produced moths, but this figure must be regarded as a minimum since a number of the pupæ which died or were eaten would, had they not suffered that fate, have gone into diapause. Of those pupæ which remained alive at the time of cotton uprooting

in the series which was examined weekly the effective survival on to the 1942 cotton crop was 4·9%. In the series which was examined at longer intervals 7·1% of the corresponding group of pupæ emerged after November, some of which undoubtedly emerged prior to the fruiting of the new crop, and 7·1% can, therefore, be taken as a maximum.

The greatest mortality was due to the depredations of rats. These usually scratch out the pupa and remove it entire, but sometimes it is broken and eaten on the spot. Rats accounted for 56·8% of the 1,070 pupæ used in the entire experiment. The main onslaught of the rat attack came in the last week of July and the first three weeks of August which coincided with the period immediately following the uprooting of the cotton, suggesting that the rats fell back on the pupæ when their previously preferred food supply had been suddenly removed. Their depredations continued sporadically right up to March. Insect predators consisting of ants and the larvæ of Tenebrionid beetles accounted for a total of 20·6% of the pupæ and were most active between April and July. Losses due to drying out or moulding only amounted to 6·4% and are confined to the periods when some pupal development is taking place. This fits in with laboratory observations in which almost the entire mortality amongst protected pupæ occurs just prior to eclosion of the adult.

This experiment is being repeated at Domira Bay in two widely separated fields, one of which has received normal cultivation whilst the other has been treated after the local African style. It is too early yet to write an interim report on these fields.

The effects of digging on pupal mortality.—The field in which the long-term cultivation experiment was carried out was sampled in July and again in November to ascertain the natural density of pupæ in the soil and the mortality in the different treatments. Unfortunately, although the figures obtained were very promising, the sample taken was too small for statistical analysis. The experiment has been repeated this year on a very much larger scale. A five-acre field was divided into 55 plots which, after the first sampling, had alternate plots dug in a chess-board effect. Six blocks for sampling were then taken at random. This ensured that each plot was uniformly surrounded by dug and undug plots. The field was sampled first at the time of uprooting and found to contain a population of just over 2,000 pupæ per acre. In the middle of November the population will again be sampled to ascertain the differential mortality between treatments. It is believed that an early uprooting and digging is a very valuable potential control measure for this area and that, quite apart from the prevention of continuous breeding, etc., its effects work in two ways : firstly by removing abruptly the existing food supplies of small insectivorous mammals and rodents and facilitating their foraging expeditions by loosening the soil and secondly by creating a steeper temperature gradient below the soil surface which will tend to protect pupæ from the long periods of intense heat whose cumulative effect is

believed to be responsible for the very long-term diapause. These field pupation experiments are therefore of the utmost importance.

The effects of larval food on the length of pupal life.—It is important that knowledge should be gained as to the effects, if any, on the subsequent pupæ of feeding larvæ on cotton fruits in various stages of development since, as has been shown by Rainey (1938–39; 1939–40), the nutritional value of bolls of various ages differs very considerably, and if one of the factors governing pupal life is nutritional, then a full understanding of the problem is essential before any alteration is made in any cropping practices existing on the Lower River in the attempted control of red bollworm. The technique employed this year was similar to that used in 1941, but with a number of modifications and would-be improvements. Advice on the method employed at Barberton for rearing American bollworm (*Heliothis*) was very kindly supplied by Mr. F. R. Parnell. Failure, however, was as complete as in 1941.

In 1943 the writer will approach the problem as a field experiment instead of as a laboratory one. A field will be laid out in randomised blocks containing five treatments. By means of the controlled removal of fruiting points, each treatment will carry fruit of a given limited period of origin only so that larvæ collected at any time from any plot can only have fed upon fruit of known age. Full-fed larvæ will be collected from the various plots throughout the season for a study of their resulting pupæ.

The effects on pupation of various humidities on the pre-pupa.—A small-scale laboratory experiment has been carried out to ascertain whether the humidity of the soil air spaces has any effect upon the pre-pupa which may affect the subsequent pupal life. Owing to the lack of suitable equipment at the Domira Bay Station it was only possible to condition soils roughly to required humidities on a small scale. The humidities chosen were 100% over distilled water, 85% over a saturated solution of potassium chloride, 75% over a saturated solution of sodium chloride and 50% over a saturated solution of calcium nitrate (P. A. Buxton and K. Mellanby. *Bull. Ent. Res.*, 1934). It was found, however, that the alleged calcium nitrate gave a humidity of about 90% instead of the required 50% and was therefore discarded. The total range of humidity used was therefore less than had been planned. An emergence of between 50 and 60 moths was obtained from each treatment and there is no suggestion of any differential behaviour.

Moth migration.—Another point in the behaviour of the red bollworm about which it is necessary to obtain information is the distance which can be travelled by moths across country in their normal dispersal and in their search for oviposition sites. The laboratory experiments carried out in 1941 showed the way to produce large numbers of moths out of season and the installation of the pump at No. 2 borehole has provided the means of growing an attractive cotton crop at a time when there is no other cotton in the area to compete with

it. 21,000 pupæ have been collected, the main moth emergence from which is expected in late October and November. A small plot of cotton was planted at the end of April under irrigation and is being used to attract the moths which are being trapped in a light trap set 7 feet above and immediately adjacent to the cotton. The moths are being marked with small dabs of paint upon the denuded thorax in such a way as to identify their day of liberation. Moths will be liberated at gradually increasing distances until the maximum range is reached.

Routine field records and pupation work.—These have been continued as in previous years to which they are in all essentials similar. The bollworm infestation this year was a light one in which the peak of the oviposition from the diapause flight attained a weight of nearly 22,000 eggs per acre during the week ending 7th March.

PROGRAMME OF WORK FOR 1943.

A point has been reached where certain of the inferences drawn from the observational work require to be checked by experiment before basing control measures on them. This experimental work is mainly concerned with the resting stage in the pupal life of the red bollworm, since it is upon knowledge of the factors controlling this that the most likely control measures rest. These factors are the conditions of nutrition, humidity and temperature in larval and pupal life. The humidity factor has already been fully explored by Mr. Mitchell at the Domira Bay Station, and has been shown to be of no importance ; the food factor has proved extremely difficult to investigate for technical reasons, although such results as have been obtained suggest that this, too, is not the dominant factor.

Work on temperature has thus become of paramount importance. This involves the exposure of larvæ and pupæ to a range of temperatures from 10° to 50°C., these temperatures requiring to be maintained constant over long periods. This cannot be carried out at Domira Bay, because ice and a continuous supply of electricity are not available there and no suitable paraffin-operated heating and refrigerating plant is obtainable. The only place where the necessary facilities exist is Zomba, where the Government have very generously provided suitable laboratory accommodation in the Chemist's section of the Department of Agriculture and housing accommodation on the adjoining experiment station, where the necessary plant material may be grown.

Mr. Pearson has therefore transferred his headquarters to Zomba and will carry out this work and also maintain certain of the permanent records. The necessary apparatus for the temperature work had

been built locally to his design and under his supervision, and preliminary work has already started. Mr. Mitchell is taking over the routine recording in the Lower River and will also tackle the nutrition problem from a new angle by means of field experiments carried out at the Chiromo Sub-Station. He is shortly transferring his headquarters to Limbe, whence both ends of the Lower River are readily accessible and where the heavy office work connected with the Lower River recording may be carried out in a relatively healthy climate. A limited amount of work only will be maintained on the Lake Shore.

The programme for 1943 is thus as follows :—

1. The observational work, mainly in the Lower River, will be maintained, comprising records of insect populations and crop development and loss in sample gardens selected on the basis of the crop census, with all relevant meteorological data.
2. Time-of-planting experiments will be continued at Chiromo, on a more limited range of dates, analysed by taggings.
3. Pupation work will be continued in all districts.
4. Pupal mortality records will be continued in the Lake Shore and Lower River areas, particularly in connection with intensive and native styles of cultivation and with dug and undug fields.
5. The effects of larval food on pupal life will be studied by controlling food supplies of natural infestations in the field by periodic stripping, and incubating pupæ so derived at constant temperature.
6. The effects of temperature during larval and pupal life on the induction and break up of diapause will be studied experimentally under controlled conditions, using a multiple temperature incubator and a constant temperature room.
7. Stainer breeding under insectary and semi-natural conditions will continue.
8. Recording work on wild host plants of stainers, the preliminary surveys for which have been started, will be continued.
9. Any special work on the Chiromo Sub-Station requested by the Agriculture and Plant Breeding Section will be done, as in previous years.

[*Included by courtesy of the Nigerian Government.*]

NIGERIA.

PROGRESS REPORT ON WORK ON COTTON IN THE NORTHERN PROVINCES FOR THE SEASON 1941-42

BY
J. K. MAYO.

Introduction.

Routine maintenance of the three best strains of cotton and their derivatives. Multiplication of a mixture of these in the Bauchi Line district. An earlier stage of multiplication at Daudawa.

Meteorology.

For cotton planted at the proper time the rainfall was satisfactory.

Breeding.

In addition to the maintenance of the improved strains, mass selection in the ordinary crop was carried on and some variable material, including native types, was obtained from Kontagora.

PROGRAMME FOR THE SEASON 1942-43.

Maintenance and multiplication as before, but no trials.

PROGRESS REPORT ON WORK ON COTTON IN THE SOUTHERN PROVINCES FOR THE SEASON 1941-42

BY
O. J. VOELCKER.

Introduction.

Routine maintenance of the purity of Ishan A was continued. The examination of rough-linted local selections was commenced.

Meteorology.

Rainfall at Moor Plantation between July and October—the critical period of growth—was slightly above average at 23·96″, but it was not well distributed. Flowering started late and ceased early, causing a severe reduction in yield from the previous season. Leaf fall occurred earlier than usual.

Genetics and Breeding.

Sixteen progeny rows of 20 plants each of Ishan A were established. Each row was bulk harvested and eight were finally selected, mainly on lint characters. These eight selections will be tested in a Latin Square layout next season.

One hundred progeny rows of cotton selected for rough lint from native farms in Benin Province were established at Moor Plantation. Nineteen were finally selected, the majority having been discarded on the grounds of jassid attack which is closely correlated with insufficiently hairy leaves.

Entomology.

The Ishan A selection plot, although surrounded by *Tephrosia candida*, suffered considerable damage from *Helopeltis*.

Summary.

Growth and yield of the Ishan A selection and multiplication plots were disappointing and *Helopeltis* damage was again severe. Work on local rough-linted cottons has been commenced.

PROGRAMME OF WORK FOR THE SEASON 1942-43.

Establishment of yield trial (Latin Square) of eight bulk-selected strains of Ishan A.

Establishment of 19 selections of local rough-linted cottons for further observation and re-selection.

WEST INDIES.

COTTON RESEARCH STATION, TRINIDAD. GENETICS DEPARTMENT.

PROGRESS REPORT FOR THE PERIOD OCTOBER, 1941—SEPTEMBER, 1942

BY

J. B. HUTCHINSON, R. A. SILOW, AND S. G. STEPHENS.

Introduction.

The rainy season was moderate, with few heavy falls and frequent breaks of fine weather, and the dry season was prolonged and severe. Such conditions suit most cottons in Trinidad, and except for some of the Asiatic material, growth and cropping were good. The Station has rarely been so free of pests and diseases. At some sacrifice of the work on perennial types, the number of stand-over plants in the 1941 close season was reduced to the barest minimum, and anthracnose was consequently very well controlled. By contrast, the retention of one important family through the 1942 close season has resulted in an early outbreak of the disease in the current season. There is always sufficient *B. malvacearum* to start an epidemic on very susceptible material, and a few types suffer heavily each year. Even in damp showery weather, however, the infection is practically confined to these types. It rarely spreads even to varieties which are found to be susceptible in other countries. Stainers, pink bollworm and *Sacadodes* only occurred in very small numbers even at the end of the season.

Genetic Research.

The Crinkled Dwarf Allelomorph Series.—It has now been shown that the five alleles at the crinkled locus fall into two series. Heterozygotes involving one mutant member of each series show complementary effects. These complementary effects between alleles are superimposed on the modifier system, which determines the general level of expression of the mutant gene and the extent of dominance in heterozygotes with normals.

Tests of normal alleles in a range of types of *G. barbadense* and *G. hirsutum* have shown that the high grade normal gene characteristic of *G. barbadense* occurs rarely in *G. hirsutum* and the low grade normal gene characteristic of *G. hirsutum*, rarely in *G. barbadense*. Crinkled and contorta mutants have only been recorded in types carrying the high grade normal. Indore crinkled arose by mutation from a low grade normal, and in consequence its heterozygote with crinkled is slightly crinkled, of about the same grade as crinkled × low grade normal heterozygotes.

St. Vincent semi-sterile rogue.—Reciprocal backcrosses between semi-sterile heterozygotes and normal Sea Island have shown that the genetic behaviour of semi-sterility can be accounted for by assuming a single gene difference with almost complete gametic viability on the female side and practically complete elimination of gametes carrying the semi-sterility gene on the male side.

Leaf Shape.—Studies of leaf shape development, which in the first instance were confined to New World cottons, have now been extended to embrace leaf shape development in the genus as a whole. Differences in leaf shape expression are dependent principally on differences in the timing of main gene action in relation to the general developmental processes of the plant. A study of the mechanism of this synchronisation is of fundamental genetic interest, since it throws light on the manner in which genes control developmental processes

Attention is now being focussed on the possibility of extending the normal developmental periods of the different leaf types, thus enabling the developmental processes affecting leaf shape to be studied over a longer period of time. One method has already been tried successfully. It has been found that in several types, leaf shape development is arrested when the peak of the grand period of growth is attained and flowering commences. By removal of sympodial (flowering) branches as fast as they are formed, it is possible to induce leaf shape development to continue beyond the normal limit.

The application of a method of comparing "developmental tracks" (*i.e.*, graphical representations of the regressions of sinus length and lobe width on leaf length in passing node by node up the main stem) has been found to be of great service in distinguishing leaf shape alleles which have very similar effects on the adult leaf shape. A genetic survey of New World cottons which has been hampered considerably in the past by difficulties in distinguishing certain alleles, has now been simplified and data which have been accumulating over several years can now be examined more critically. It is hoped to publish papers on these studies shortly.

The uncommon situation at the leaf shape locus in Asiatic cottons, where in compounds certain mutants induce mutation of other alleles to their own level, has been under investigation. Previously it has not been known whether the effect occurred at gametogenesis or earlier, in somatic tissue. Recent critical measurements have shown that plants which, from their parentage, should be compounds, but which breed as homozygous mutants, are of the latter genotype in the vegetative stage. The mutation-induction must therefore occur early in the ontogeny of the plant.

Anthocyanin inheritance.—The investigation of anomalous anthocyanin segregates in Asiatic cottons has been continued with a view to deciding between the alternative interpretations of close linkage and multiple allelomorphism with pleiotropy. Amongst some 2,000 backcross plants derived from a R_2^{CS}/R_2^{NO} compound, two

anomalous segregates appeared. One of them was a possible loss mutation from R_2^{NO}, but the other combines the vegetative and floral characteristics of R_2^{NO}, red plant body and red margin to petal, with the red anther characteristic of R_2^{CS}. Since red anthers only occur in two of the fourteen known alleles, both uncommon, it seems unlikely that this new anomaly is a mutant. On the other hand, recent reports on a strictly comparable anthocyanin series in corn record the occurrence of similar anomalies, which, since they occur on homozygous types, cannot be regarded as cross-over products.

Lint colour.—A survey of lint colour in Asiatic cottons is in preparation for publication. Coloured lint, which is the primitive condition in the genus, is much more common in *herbaceum* than in *arboreum*, though usually of lower intensity. Three main loci are concerned, at one of which a multiple allelomorph series occurs. On the whole there is a very characteristic difference in modifier level between the two species, high or intensifying in *arboreum*, low or suppressing in *herbaceum*, but the distinction is not absolute. In view of the high chromosome number of cotton (n=13 in Asiatic species) and the fact that only about 26 genes are known in these species which are suitable for linkage searches, it is surprising that linkages involving each of the three lint colour loci should have been identified. Six linkage groups, involving thirteen genes, are now known in the Asiatic cottons :—

L 15 *Cu* 19 Lc_1 (Hutchinson, 1934 ; Yu, 1939 ; Silow).
H_a 6 Lc_2 (Silow).
Y_a 24 Lc_3 (Silow).
P_b 16 *Ne* (Govande, 1940).

Yellow seedling 9 R_2 (Yu, 1939).

$Y_b - R_3$ (very closely linked, possibly allelomorphic). (Silow).

(L=leaf shape ; *Cu*=curly leaf ; Lc_1, Lc_2, Lc_3=lint colour ; H_a=glabrous lintless ; Y_a, Y_b=corolla colour ; P_b=pollen colour ; *Ne*=nectaries ; R_2, R_3=anthocyanin.)

Six further genes have been described or found so recently that they have not yet been included in any extensive linkage searches.

Inheritance of "Corky."—The genetic analysis of "corky" becomes steadily more complex as data are collected. It appears now that dominant corky homozygotes obtained in F_2's of Bourbon × Sea Island crosses are completely sterile and very often lethal. This type of corky is therefore distinct from the type obtained in *G. thurberi* × Sea Island crosses, where homozygotes are viable, mildly corky, completely or partly fertile, and recessive to the normal type. Further backcrossing of both types of corky heterozygote to the Sea Island background tend to exaggerate rather than diminish these differences. Both corky types appear to be determined by two (complementary) factors, although in the case of the Bourbon–Sea Island corky type, critical evidence is difficult to obtain. Owing to

differential viability, selfed families give unreliable ratios, and double recessive normal types, *aabb*, which should give the critical ratio 1 corky : 3 normal on crossing with corky heterozygotes (presumably *AaBb*), have not yet been isolated. It was believed at first that Bourbon and Sea Island types which gave normal F_1's in Bourbon × Sea Island crosses, lacked both complementary factors, (*aabb*), but it is now clear that they carry suppressors of cork since on crossing with corky heterozygotes they give all normal progenies.

Corky types obtained in the transference of *G. raimondii* characters to Sea Island are similar phenotypically to Bourbon–Sea Island corky types. Heterozygotes on selfing, however, do not show the high lethality among the progeny which is characteristic of the latter type, and they offer more promise of straightforward genetic analysis.

Inheritance of fuzz and tuft.—Four years' extensive study of fuzz and tuft distribution in Upland, Bourbon and *barbadense* types, has shown clearly that the present method of grading " phenotypic end points " on the mature seed is not likely to yield results of either genetic or practical interest which are in any way commensurate with the labour involved. Work carried out so far has shown that if fuzz alleles exist, their individual effects are not so large that they may be separated with any confidence from other genetic and environmental effects. Different backgrounds affect fuzz intensity, but as much variation is found in progenies of crosses between phenotypically similar parents of the same subspecies, as is found in progenies of crosses between phenotypically distinct parents belonging to different species. The only point of practical interest which has been brought out by these studies is that low fuzz cover is associated with low lint cover, so that a naked or tufted seed is potentially at a disadvantage, as compared with a fuzzy seed, in the production of a high lint index.

Cytological work and the effect of colchicine.—A cytological study of a colchicine-produced tetraploid of *G. arboreum* (N14) and some of its triploid hybrids with wild diploid species has been submitted for publication. The results contribute further evidence with regard to the relative homologies existing between the chromosomes of Asiatic, Australian and New World diploid species. The possible effect of such homologies on the value of amphidiploid synthesis in practical breeding is discussed.

The production of a partly fertile hexaploid from the sterile triploid *G. barbadense* × *G. raimondii* by colchicine treatment, has enabled *raimondii* characters to be transferred to the Sea Island (*G. barbadense*) background. In addition to readily scorable characters like large petal spot, corky, smooth boll, boll index, etc., it is hoped that some of the genes responsible for determining the general size and vigour of the *raimondii* parent may have been introduced into the Sea Island genotype. The types obtained in the second backcross are certainly vigorous, but it is not yet apparent how much of the vigour may be due to heterosis. Types with larger bolls than Sea Island, and also types whose seeds show an exceptionally good cover of lint, have been

selected. One of the defects of the Sea Island (V.135) seed is the sparse lint cover at the apex which seems to be associated with tufted and naked seeds. It might have been expected that such a wide cross involving a parent with very poor seed hairs (?lint or fuzz hairs) would have produced hybrids with poor lint. This has not proved to be the case, however, since none of the second backcross plants examined were below the Sea Island class in lint length, and many were not inferior in " feel." Selfed plants from the first backcross, on the other hand, although good, were definitely below the ordinary Sea Island class, so that any possible practical value of the selections can not yet be estimated.

Interspecific incompatibility.—Crosses between diploid N14 × wild diploid and autotetraploid N14 × wild diploid show differences in compatibility. An explanation of these differences has been offered on the basis of endosperm/zygote genom balance after fertilization. The normal endosperm/zygote genom ratio is 3 : 2 in a selfed seed, but in a seed resulting from interspecific cross fertilization the ratio will be upset if the genoms of the parents differ in " potency." Differences in cross compatibility between diploid and tetraploid N14 have been explained on the hypothesis that certain wild diploid species have genoms which are twice as potent as that of diploid N14 and hence equivalent in potency to that of tetraploid N14.

A preliminary survey of data obtained by Skovsted and others at this station suggests that incompatibility between Asiatic cottons and wild New World diploid cottons is due, *in general*, not to failure of cross fertilization, but to the failure of the cross fertilized seed to develop. It may be that endosperm/zygote balance is the cause of this incompatibility. On the other hand it appears that the majority of incompatible crosses between New World diploid species is due to the failure of fertilization. There is a possibility then, that incompatibility in *Gossypium* as a whole may eventually be classified into two main types. Bearing this possibility in mind, further data relating to interspecific compatibility in cotton are to be collected. Recently techniques have been developed for (1) culturing immature embryos *in vitro* (Blakeslee, Conklin and van Overbeek, 1942), and (2) overcoming failure of pollen to effect cross fertilization (Eyster, 1941, Lewis, 1942, and others). The possibility of using these techniques in analysing interspecific incompatibility in *Gossypium* is to be explored.

Quantitative inheritance.—In the last report it was noted that U.4 failed to compensate in number of bolls for the greater boll size of Triumph. Since the relative importance of these two factors in determining yield is under study in the cross between them, the two parental lines were grown in small replicated experiments on fields of different fertility. On a low-lying, moist field of good fertility, which sustained a long cropping season, U.4 gave twice as many bolls as Triumph, but as they were less than half the weight, the yield was only about three-quarters of that of Triumph. On an equally fertile field which dried up sooner, the boll size relationships were much the

same, but U.4 only produced a few more bolls than Triumph and its yield was consequently little more than a third of that of Triumph. On poor land, on the other hand, the boll weight of Triumph was only half that on good land, while that of U.4 was only reduced by a quarter. Boll number was also more heavily reduced in Triumph than in U.4, and the nett result was that the yield of U.4 was nearly twice that of Triumph. Yield trial data with Sea Island cotton indicate that, in general, differences in response to different fertility levels are not so great as in the U.4 *v.* Triumph trial, but similar differences have been observed in the response of MSI and superfine varieties to different seasons. It is evident that detailed knowledge of the physiological relationships between yield components will be necessary before any great advance can be made in breeding varieties to fit particular environmental conditions.

In the inter-Upland hybrid lines, comparison of F_4 means with F_3 parental values showed that the parent–offspring correlation was negligible in bolling, seed cotton per boll, and lint yield, low in seed weight, fair in lint index and lint length, and very high in ginning percentage. Since the cross was between Triumph and U.4, which are widely different Upland types, the genetic variance was probably higher than is normally found in variable crop populations. As in this material single plant selection was inefficient on most characters, it is unlikely that mass selection even in genetically variable field populations will lead to an advance comparable with that obtained by selection on progeny means.

Selection for a long season cotton progressed favourably in an intra-*barbadense* cross. As expected, the isolation of long growing season types offered no difficulty, but there may be some difficulty in combining a long growing season and a short cropping season. Many perennial cottons have a short cropping season, so that there is no reason to suppose that the combination will not be realised in time.

These studies in quantitative inheritance are, of course, only in the early stages, but they have already emphasised very strongly the need for a careful examination of the aims of a plant-breeding project, and of the means available for attaining them. The assessment of the relative importance of yield components in determining the final return is alone worth considerable preliminary study before embarking on any breeding scheme. The breeding of varieties designed to escape insect attack requires an even more detailed knowledge of the interactions of habit characters and yield components. It is evident, therefore, that advance in applied genetics depends on close association with applied physiology.

Cotton Prospects in the Caribbean Colonies.

J. B. Hutchinson toured Jamaica and the Bahamas in May–July, 1942, with W. H. Edwards, Entomologist in the Agricultural Department, Jamaica. Both Colonies have stainers, pink bollworm,

and cotton leaf worm, and Jamaica has leaf blister mite. Stainers are obviously the limiting factor in cotton development, and no industry could be started with a hope of success unless stainers can be controlled or avoided. Even assuming that stainers can be controlled, conditions are not favourable for the development of Sea Island cotton. In Jamaica ample land is available in the southern plains, but these are comparatively dry, having an average rainfall of 30–40 inches, with an uncertain distribution. Bourbon cottons are indigenous, and, being perennial, flourish in spite of the uncertain water supply. Scattered spontaneous shrubs produce abundant crops of clean cotton. Whether commercial cultivations would escape stainer damage depends on the relative attractiveness of cotton and silk cotton (*Ceiba*), on which the most important stainer populations appear to develop.

In the Bahamas there is a very thin soil cover over honeycomb limestone rock, and the cultivation of annual crops usually leads to extensive denudation. Pot holes and fissures are so frequent that perennial shrubs and small trees can be established with reasonable root room, and since the surface stones and soil are less frequently disturbed among perennial crops, soil losses are reduced. The native cotton is a perennial *G. hirsutum* var. *punctatum* (*G. religiosum*). Less is known of its spinning properties than of the properties of the Bourbon group to which the Jamaican types belong, but it seems to produce a fair marketable cotton. The basic problem in the Bahamas, as in Jamaica, is the stainer, and only if stainers can be controlled or avoided will it be worth while attempting to develop a perennial cotton cultivation.

PAPERS PUBLISHED OR SUBMITTED FOR PUBLICATION.

Hutchinson, J. B. "The Effect of Environment on Hair Characters and Spinning Value in Sea Island Cotton."

Hutchinson, J. B., and Manning, H. L. "The Efficiency of Progeny Row Breeding in Cotton Improvement."

Silow, R. A., and Yu, C. P. (1942.) "Anthocyanin pattern in Asiatic Cottons." *J. Genet.* **43**, 249–84.

Stephens, S. G. "Colchicine-produced Polyploids in *Gossypium*. *J. Genet.* **44**, 273-95.

SUMMARY & PROGRAMME.

In view of the Corporation's decision to transfer their cotton research work to Uganda after the war, no further development of the programme of research in Trinidad is contemplated. All genetic investigations are long-term projects and the completion of the studies now in hand will provide a full programme for several years. The studies of gene action, main gene–modifier interaction, dominance, and linkage, together with the newer quantitative inheritance experiments, are providing the necessary basic knowledge for the development at the new station of research in applied genetics.

PHYSIOLOGICAL DEPARTMENT
OUTLINE REPORT ON WORK DONE DURING 1942.

BY

T. G. MASON and E. PHILLIS.

Six papers were prepared and submitted for publication. A great deal of time was spent on working out new methods of chemical analysis. The main subjects investigated were hydration and mineral nutrition.

Hydration.

Three techniques are in use. There is first of all the intact plant. Here we merely determine the effect on hydration of *growing* the plant in different mineral solutions. The second method involves the use of discs punched from leaves and floated on salt solutions. The third method is new. It consists in growing the plant for about two months in water culture in a full nutrient solution. About 75 per cent. of the leaves are then removed, the full nutrient solution replaced by the experimental solution and its effect on the hydration of the leaves still on the plant determined.

While there are some anomalies between the results obtained using the three methods, all nevertheless point to some effect of electrolytes on protoplasmic hydration. Leaf water content can apparently be influenced either by changing the amount of protoplasm or as a result of the effect of electrolytes on hydration capacity of protoplasm. The former we term the " bulk factor " and the latter the " hydration factor." As a mineral element may affect both factors, it is difficult to determine the specific effects of the individual elements. It is hoped that this work will throw light not only on the problem of hydration but will also help to explain what are the internal causes of leaf senescence.

Mineral Nutrition.

A method of determining nitrogen starvation has been suggested by the Punjab workers. It depends on the accumulation of tannin in the leaves of nitrogen-starved plants. Our own work indicates that the presence of large amounts of tannin is not peculiar to nitrogen-starved plants, but that unbalanced nutrition, however brought about, leads to the accumulation of tannin.

We are also investigating the possibility of using the leaf disc technique as a means of determining the mineral status of the plant. Discs taken from potassium-starved plants appear to respond to added potassium, but discs taken from nitrogen-and phosphorus-starved plants show no response to additions of these elements. The further development of methods of diagnosing mineral shortages calls for the laying down of large-scale manurial experiments under widely diversified conditions.

While a good deal of work has been done on the effects of varying the supply of the mineral elements, as yet little attention seems to have been paid to the effects caused by different environmental conditions. We find, for instance, that when the supply of phosphorus is increased from starvation levels, under dark humid conditions, increasing phosphorus makes the plant more leafy, while under bright dry conditions root development is promoted.

COTTON EXPERIMENT STATION, ST. VINCENT.

PROGRESS REPORT FOR THE SEASON 1941-42

AND

PROGRAMME OF EXPERIMENTS FOR THE SEASON 1942-43

BY

H. L. MANNING.

Introduction.

Climatic conditions were normal throughout the island, and but for the extensive attacks of cotton leaf worm it is estimated that good yields would have been obtained. Pink bollworm infestation at the Experiment Station was rather later than usual, so that better yields were obtained than those of the past three seasons.

The total area under cotton amounted to 4,827 acres of which 2,765 were peasant cultivation. The peasant yield per acre was 79 lb. of white lint and that of the estates 160 lb. The island yield of 547,283 lb. of white lint gave an average yield of 113 lb. per acre.

The island's planting seed supply area was smaller than in 1940–41 ; 82 acres produced 23,207 lb. of white lint and an adequate quantity of pedigree seed was available for planting the 1942–43 crop.

Genetics and Breeding.

Superfine Breeding Trial.

Ten progenies were planted in a randomized complete block design. Germination and early growth were excellent. Lack of familiarity with nitrate of soda, the only available nitrogenous fertilizer, caused mechanical damage from which apparently the plants never fully recovered. Yield was corrected for stand by the analysis of covariance. Characters with low environmental variance, viz., seed weight, lint index, ginning percentage and lint length, were analysed, however, with the ordinary analysis of variance.

Two main V.135 strains, V(37)11 (4 progenies) and V(30)46 (2 progenies), were compared with three BSI progenies from the 1940–41 Main Breeding Trial. In addition, one other progeny, a doubled haploid of the type 18 strain of V.135, was planted in the trial. Germination and subsequent growth of the last were so poor that records were not included in any of the statistical analyses.

TABLE I.

SUMMARY OF SUPERFINE BREEDING TRIAL.

Variety.	*Total Seed Cotton. gms.*	*Total Lint. gms.*	*Seed Weight in mgms/seed.*	*Ginning Percentage.*	*Lint Index. mgms/seed.*	*Lint Length. mm.*
V(30)46	94·8	23·9	135·5	23·6	41·9	60·9
V(37)11	83·3	20·3	133·9	24·5	43·4	60·2
BSI	94·9	24·5	123·1	26·1	44·1	59·3
C.V. %	24·0	24·0	2·3	2·5	3·6	1·7
F for Varieties	N.S.	N.S.	***	V.S.	***	***

Table I shows a summary of seed cotton characters of the main strains with the significance of differences between progenies. In yield analysis it was seen that, while the analysis of covariance provided suitable adjustments in so far as groups were concerned, the experimental error was too high to enable detection of differences less than 40%. Significant differences were recorded for all other characters.

V.135.—The essential differences between the high bolling, low lint per boll V(30)46 group and the low bolling, comparatively high lint per boll V(37)11 group (due to the comparatively high lint index of the latter) were maintained. Seed cotton yields of the V(30)46 progenies were rather higher, but the higher ginning percentage of the V(37)11 progenies reduced the differences in lint yields.

BSI.—The high yielding selections of the 1940–41 trial maintained their promise. While seed cotton differences were small, the higher ginning percentage resulted in better lint yields than V.135 though the differences were not significant.

Between V.135 and BSI.—Both are high yielding superfine varieties with approximately the same seed cotton yields. BSI, however, has a smaller seed than V.135 and about the same lint index as V(37)11, thus giving a greater lint yield for the same seed cotton. Spinning test data supplied by the Shirley Institute show that, while the effective length of the BSI strains is 60 thirty-seconds of an inch, the low hair weight per cm. (about 90) is less than V.135 and produces a yarn whose strength is as good as V.135. The residual variance remaining in BSI is sufficient to obtain a ready response to selection for the characters ginning percentage, lint index and lint length. From small-scale spinning test results it appears that increase in lint index is likely to lead to loss of quality. Increase of lint length beyond that of V.135 is not likely to be profitable and the most promising line of advance lies in a search among BSI material for variability in seed weight.

THE VH BREEDING TRIAL.

Thirty-one progenies were tested in a balanced incomplete block trial, with 31 blocks of 6 eight-plant plots each. Experience with replicated progeny row technique has shown that certain characters with low environmental variance can be assessed with sufficient

accuracy on plot sample data. For characters with high environmental variance, however, the entire plot population was used in the statistical analyses. A general reduction in boll weight values in selfed material accounts for slight discrepancies between bolling × lint per boll and total lint yield.

Three main strains VH(38)8, 9 and 10 provided the material for the trial. VH.8 has the high bolling, long lint and growth characteristics of V.135, while early VH.10 selections resembled MSI in boll weight and rather lower bolling. Under field conditions the VH.9, which combines desirable characters from both parents, has the best appearance and two sub-strains VH.9–5 and VH.9–11 were included.

TABLE II.

Summary of VH Breeding Trial.

Strain.	*Days to 1st Flower.*	*Plant Height. cm.*	*Boll Loc.*	*Bolls.*	*Seed Cotton/ Plant. gms.*	*Lint/ Plant. gms.*	*Lint/ Boll. gms.*	*Seeds/ Boll.*	*Lint Index. mgm/ seed.*	*Seed Weight. mgm/ seed.*	*Gin. %.*	*Lint Length. mm.*
VH.8 ...	65·6	156·9	3·32	48·9	114	33	0·70	11·9	59·0	141	29·4	60·4
VH.9–5 ...	67·9	154·1	3·36	47·4	118	34	0·76	12·6	60·8	144	29·8	60·0
VH.9–11 ...	67·8	152·6	3·38	47·2	117	34	0·76	12·2	62·2	148	29·6	59·7
VH.10 ...	64·8	153·6	3·38	44·1	104	30	0·71	11·5	62·1	147	29·9	59·4
C.V. % ...	3·4	7·5	2·4	12·7	14·8	16·7	7·4	8·2	4·0	2·5	2·2	1·4
F for Strains	***	N.S.	***	**	***	**	***	***	***	***	***	***

Reference to Table II shows that the precision of the experiment was good enough to detect lint yield differences of 20% (S.E. (diff.) 10% of G.M.). This compares favourably with results from randomized complete block designs at this Station in which, with fewer progenies and 10 replications, it was only possible to detect differences of 20–30%. Professor G. M. Cox, of the University of North Carolina, kindly provided a form of statistical analysis for comparisons both between and within groups. With this latter comparison a valuable estimate is provided of the extent of the variability which remains in the various sub-strains.

Significant differences between groups were recorded for all characters except percent. shedding and plant height. VH.8 progenies were, as expected, better " bollers," taller plants, and had longer lint than those of VH.9 or VH.10. Their resemblance to V.135 superfine in morphological characters is further shown by the lower boll weight characters associated with the best " bollers." The VH.10 progenies gave disappointing lint per boll values. The VH.9 progenies with high lint per boll and high bolling gave the most desirable character recombinations.

Significant differences within groups were recorded for " flowering," bolling, lint length, lint index, seed weight and ginning per cent. In general the residual variance was higher in VH.9–5 and VH.10 than within strains VH.8 and VM.9–11.

VH Small Bulks Trial.

Five VH bulks were tested against V.135 in a randomized block trial. Blocks were laid out at the Experiment Station and at Grand

Sable on wilt-infected land.* On this latter area it was hoped to obtain a line on possible wilt resistance in the VH hybrids. Unfortunately there was no evidence of difference in susceptibility to wilt and from the point of view of experimental precision the choice was not happy. The stand lacked uniformity, but was not poor enough to make an analysis of covariance profitable.

The bulks grown were of the families VH(40)1=VH.8; VH(40)5=VH.9–5; VH(40)11=VH.9–11; and VH(40)16=VH.10; the parental groups of the VH Breeding Trial above. In addition, a re-selection from the Small Bulks Trial of 1940–41, VH(39)7 of VH.8 ancestry, was tested for high yield possibilities. The V.135 standard of comparison was a bulk of a V(30)46 progeny.

Lint indices, seed weights and ginning percentages were essentially similar to those obtained in the VH Breeding Trial. Lint yields are given below individually and for locality and for the mean of the two. No significant differences were recorded for lint yield. In the analyses of variance for lint index and ginning percentage both VH.8 and V.135 were significantly poorer than the rest. Between these latter bulks VH.9–5 was significantly better than VH.10 but not than VH.9–11.

Lint Yield in Lb. per Acre.

	VH(39)7.	*VH.10.*	*VH.9–11.*	*VH.9–5.*	*VH.8.*	*V.135.*
Grand Sable...	162	160	171	155	178	154
Experiment Station ...	440	410	380	380	350	350
Mean...	301	285	276	268	264	252

Discussion of VH Breeding Results.

VH.8.—In the VH Breeding and Small Bulks Trials VH(40)1 family of VH.8 has proved disappointing, and in addition the spinning tests of 1940–41 did not confirm those of the 1937–38 season. At the same time the high yielding VH(39)7 bulk, another VH.8 family, suggests that re-selections from small bulks of this strain may offer some scope for improvement, provided spinning tests are satisfactory. In the main, VH.8 builds up its yield in the same way as V.135, in which high bolling is offset by low lint per boll.

VH.9.—The VH.9 material, particularly VH.9–5, includes a number of progenies combining good values for bolling, seeds per boll and lint index. This combination gave the highest mean lint yield in the VH Breeding Trial. A high value of seeds per loculus without any material reduction of loculi per boll gives high lint per boll without running the risk of loss of fineness inherent in high lint per boll obtained by selection for high lint index. Since the quality of this strain is perhaps not quite up to V.135 standard, it is advisable to select in it chiefly for fineness. With the rather high residual variance remaining in VH.9–5, both for these and certain other desirable characters, it is clear that given satisfactory spinning test results, it will offer the greatest scope for future improvement.

* The cause of the wilt is unknown. It only occurs in a few fields, and is not at present of any agricultural importance.

VH.10.—Spinning tests of VH material in 1940–41 indicated that this family was within the range of variation of V.135. In the present VH Breeding Trial its lint yield was rather disappointing. With low bolling its unexpectedly low lint per boll gave a rather lower lint yield than either VH.9–5 or VH.9–11. In the Small Bulks Trial it maintained its early promise, outyielding both VH.8 and VH.9. The previous VH.10 spinning tests were so good that further selections are to be made in the strain.

Small Scale Spinning Test Data provided by the Shirley Institute.—Differences in yarn strength were not great. The VH.10 strains were least neppy, and stronger than VH.8. The VH.9 group provided the next strongest after VH.10, notably VH.18, 19 and 20. It is satisfactory to note that samples appeared to be on the whole distinctly stronger than VH samples tested in 1940–41 and most of them are equal in spinning value to a commercial V.135 recently spun at the Institute.

VARIETY TRIAL.

Two recent importations of Sea Island cotton from the United States, Bleak Hall and Seabrook, were grown in a randomized block Variety Trial with V.135, the three main VH strains and Sea Island Fuzzy, a mutation of V.135. Bleak Hall is the original American superfine strain and has the boll characteristics of the superfine group, while Seabrook has the large bolls and comparatively low bolling of the ordinary group. Data are given in Table III below.

TABLE III.

SUMMARY OF VARIETY TRIAL.

Variety.	*No. Days to 1st Flower.*	*Bolling/ Plot of 32 Plants.*	*Seed Cotton/ Plot. gms.*	*Lint/ Plot. gms.*	*Lint/ Boll. gms.*	*Seeds/ Boll.*	*Lint Index. mgm/ seed.*	*Ginning %.*	*Lint in lb. per acre.*
V.135	74·0	1,426	3,430	871	0·61	13·6	45·0	25·4	327
VH.8	79·0	1,204	3,281	940	0·78	14·6	53·7	28·6	353
VH.9	75·2	1,299	3,495	1,015	0·78	14·6	53·4	29·0	381
VH.10	75·4	1,227	3,120	917	0·75	12·7	59·2	29·4	344
S.I.F.	79·1	1,126	2,974	727	0·65	14·3	45·2	24·4	273
Seabrook ...	72·6	998	2,651	783	0·78	12·8	61·3	29·5	294
Bleak Hall ...	71·5	1,323	2,659	672	0·51	13·6	37·5	25·3	252
C.V. %	2·6	10·2	11·6	13·3	5·1	6·0	3·7	1·7	—
F for Varieties..	***	***	***	V.S.	V.S.	***	V.S.	V.S.	—

Significant differences between varieties were recorded for all characters. A considerable proportion of soil heterogeneity has been eliminated by blocks, giving a relatively high precision for an experiment with such small plots (1/170 acre).

The superiority of the VH hybrids in yield is again demonstrated. Differences in seed cotton yield were much less than in lint yield and it is evident that success in breeding a better strain than V.135 depends on increasing lint per boll without materially reducing bolling. This trial bears out the VH Breeding Trials in showing that VH.9 is the most promising for this purpose. The VH.8 family included in this trial differs in general characters from the families of this strain in

the Main VH Breeding and Small Bulks trials. Since this family has high lint per boll in addition to its known high bolling, it appears that useful selections might be made in it.

Under the conditions of the trial Bleak Hall failed to compete with the West Indian varieties. Seabrook yielded well, and since the stock is more variable than the existing stocks of West Indian varieties it may be useful for selection.

Manurial Experiment (Varietal comparisons included).

Through the courtesy of the Agricultural Department, who supplied compost prepared by the Indore process, it was possible to make field observations during 1940–41 on a small composted cotton area. Growth was so good that a randomized block $3 \times 2 \times 2$ partially confounded experiment was laid out in the 1941–42 season. Three strains, V(30)46—a high bolling V.135 selection—, V(37)11—a high boll weight V.135 selection—, and a BSI selection, were included with a view to obtaining some information on the interaction between bolling and boll weight in the synthesis of yield. Compost at 11 tons per acre (108 lb. nitrogen), nitrogen at 400 lb. nitrate of soda (56 lb. nitrogen) and control provided the manurial comparisons. The compost was applied two weeks before and the nitrate of soda five weeks after planting. The rapid and sustained effect due to compost was the most striking feature of the trial.

A summary of morphological and seed cotton characters is shown below in Table IV, which records differences in the first part due to treatments ignoring varieties, and in the second varietal differences ignoring treatments. This arrangement was possible since there were no significant interactions between variety and treatment, except for ginning percentage.

Plant height data showed that growth due to nitrogen alone continued until the 133rd day, though the nitrogen plots never attained the height of the composted plots. During the season it was seen that the control and composted plots showed the characteristic yellow green leaf colour of nitrogen deficiency when compared with nitrogen plots. Since the nitrogen equivalent in the composted plots was 108 lb. against the 56 lb. of the nitrate of soda plots, the apparent nitrogen deficiency of compost was the more remarkable.

Differences due to compost were highly significant for earliness, plant height, shedding and total lint. Significant differences due to nitrogen were obtained as would be expected under St. Vincent conditions for plant height, total lint, lint index, seed weight and ginning percentage. The effect of nitrogen on the last three characters is in agreement with the results of previous experiments. Analysis of the data shows that while the effect of compost on lint index and ginning percentage was not significant, the response to nitrogen was favourable and significant. The relative increase in lint index due to nitrogen was greater than for seed weight, resulting in a higher ginning percentage.

Varietal differences were not marked, though there was evidence of a balance between lint per boll and number of bolls in St. Vincent strains. The V(30)46 with low lint per boll had a high yield of total seed cotton, while the V(37)11 with higher lint per boll produced rather less seed cotton, but the same amount of lint as a result of its better ginning percentage. Lint yield of BSI was slightly better than that of the St. Vincent strains owing to its higher ginning percentage. The significance of the Varietal × Nitrogen interaction in ginning percentage is not unexpected. For some time it has been noticed that high lint index strains do not respond as readily in lint index and ginning percentage to nitrogen manuring as do strains with lower lint indices.

The experiment must be regarded as a preliminary exploration of the effect of compost since no equivalent inorganic treatments were included. There is some evidence, however, that the yield increment due to compost cannot be due to nitrogen alone. The nitrate of soda increased lint index significantly whereas the compost, with twice as much nitrogen and applied seven weeks earlier, reduced it. An experiment will be laid out in the coming season to compare the effect of compost with that of its more important mineral equivalents applied at the same time.

Data supplied by the Shirley Institute show a reduction (not significant) in corrected Lea Count × Strength product due to compost treatment when compared with control and the nitrogen plus compost treatments.

TABLE IV.
SUMMARY OF MANURIAL-VARIETAL TRIAL.
3 Varieties × 2 Levels Nitrogen × 2 Levels Compost.
Plot Size = 4′ × 66′. Single Plant per Hole.

TREATMENT or Variety.	*1 Days to First Flower.*	*2 Plant Height. cms.*	*2 Sheds. %.*	*3 Seed Cotton/ Boll. gms.*	*3 Lint/ Boll. gms.*	*1 Seed Cotton. gms.*	*1 Lint. gms.*	*1 Seed Weight. mg./ seed.*	*1 Lint Index. mg./ seed.*	*1 Ginning %.*
Control ... ... N_0C_0	75·7	105·3	34	2·45	0·563	2,630	656	128·0	42·9	25·2
Nitrogen ... ... N_1C_0	74·3	118·0	36	2·49	0·566	3,189	811	133·2	45·4	25·5
Compost ... ... N_0C_1	66·3	128·0	27	2·56	0·596	4,648	1,156	128·3	42·3	24·9
Nit. and Comp. ... N_1C_1	66·9	143·1	32	2·65	0·603	5,201	1,313	133·1	44·8	25·4
C.V. %	5·8	9·6	9·6	5·7	6·0	12·1	12·3	2·2	3·5	1·4
F—for COMPOST ...	***	***	**	**	**	***	***	N.S.	N.S.	N.S.
F—for NITROGEN ...	N.S.	**	N.S.	N.S.	N.S.	**	***	***	***	**
V.1 = V(30)46	70·3	121·7	32	2·52	0·533	4,083	965	135·8	42·1	23·6
V2 = V(37)11	70·9	128·8	35	2·76	0·610	3,816	969	135·8	46·3	25·5
V3 = B(40)19	70·4	120·4	31	2·42	0·603	3,852	1,018	120·2	43·3	26·5
F—for VARIETY ...	N.S.	N.S.	N.S.	***	***	N.S.	N.S.	***	***	***

N.B.—1 = Data on WHOLE PLOT.
2 = Data on 10% POPULATION.
3 = Data on 100-BOLL SAMPLE.

Sea Island Variety Collection.

Sea Island varieties were maintained in variable bulk plots and type progenies of comparatively pure strains. Detailed morphological and seed cotton analyses were performed for the accumulation of comparative data on the Sea Island group of cottons.

PROGRAMME OF WORK FOR THE 1942-43 SEASON.

1. *VH Breeding Trial.*—49 progeny balanced incomplete block. Arrangement in the field to be such that characters subject to low environmental variance can be analysed as a randomized complete block with eight replications. Experimental efficiency can also be estimated. Selections to be based mainly on small-scale spinning tests and strains with best means and highest residual variance.

2. *Superfine Breeding Trial.*—Randomized Complete Block with 10 replications. One strain each of V(30)46, V(37)11, Type 18 doubled haploid, Seabrook, and four BSI's. Adjacent progeny rows for selfing have been grown of these eight strains, and in addition eight more V.135 strains have been maintained in this way to increase the amount of selfed superfine seed available for Station multiplication.

3. *Small Bulks Trial.*—On bench terraces for poor land response and at Grand Sable. Four VH strains. Families for possible re-selection from bulks. Randomized complete block design.

4. *Variety Trial.*—Randomized complete block with 8 replications. V.135, VH.8, VH.9, VH.10, Bleak Hall, Seabrook, MSI and Porto Rico.

5. *Manurial Experiment.*—Three nitrogen × two compost × two phosphate × two potash to investigate the compost effect on cotton growth and yield. First order interactions partially confounded.

6. *Miscellaneous Experiments.*—In addition to type collection and variable bulk maintenance, a randomized test of Red Sea Island × VH material.

7. *V.135 Multiplication.*—An area of approximately one acre to be maintained at the Station for obtaining seed supply for Island's multiplication area.

EMPIRE COTTON GROWING CORPORATION

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List of Publications issued to date. Those still in print can be obtained direct from the Corporation at the above address. Those out of print are marked with an asterisk. The prices include postage.

GENERAL AND TERRITORIAL.

"Cotton Growing within the British Empire and the World's Capacity for Consuming Cotton Goods." J. W. McConnel. 1921. Price **2s.**

* "Cotton Growing in Nigeria." Sir Hector Duff. 1921.

"The Extension of Cotton Cultivation in Tanganyika Territory." Major Hastings Horne. 1922. Price **2s.**

* "Cotton Cultivation in Nyasaland." H. C. Sampson. 1922.

"Cotton Growing in South Africa." G. F. Keatinge. 1923. Price **2s.**

* "Cotton Growing within the British Empire." L. G. Killby. 1924.

"A Cotton Research Station for the British Empire." Professor J. B. Farmer and Mr. L. G. Killby. 1925. Price **2s.**

"Report on the Cotton-Growing Industry in Uganda, Kenya, and the Mwanza District of Tanganyika." Col. C. N. French. 1925. Price **1s. 3d.**

"Memorandum by the Mechanical Transport Sub-Committee." Mr. G. H. Baillie, Mr. R. H. Brackenbury, Col .C. N. French. 1925. Price **2s.**

"Report on the Cotton-Growing Industry of Nigeria, 1926." Col. C. N. French. 1926. Price **2s.**

* "The Principles and Practice of Yield Trials." F. L. Engledow and G. Udny Yule. 1926.

"Report on Suitable Rotation Crops for Cotton." H. C. Sampson. 1927. Price **1s.**

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